Specifications for Building Section No. 9, of the New Croton Aqueduct.

(Selected as a typical section of the work.)

Concluded from Page 150.

MASONRY.

30. All masonry is to be laid in hydraulic cement mortar, unless otherwise specified.

The contractor, at his own expense, must conduct the the water away from any point where masonry is being laid, by the use of pipes or other efficient means, and must prevent water from flowing over or exerting pressure upon the masonry till it is fully set. Under no circumstances shall masonry be laid in water.

31. The work of masonry in the tunnel must progress simultaneously with the work of excavation; and must follow it at a distance of not less than 200 nor more than 500 feet from the heading, unless otherwise permitted.

32 The work in all cases shall be well and thoroughly bonded; and the system of bonding ordered by the engineer shall be strictly followed.

33. Strong centers, made to fit the curves in the line of the masonry, and satisfactory moulds or forms, shall be provided by the contractor; and when they lose their proper dimensions or shape, they shall be replaced by others. They shall, before use, be scraped free from cement or other dirt. The centers upon which the top arch is formed shall be slightly lowered before the backing is placed on said arch, but not until in the opinion of the engineer the mortar has sufficiently set.

34. At all places where there is a change in the shape of the masonry, at all angles, shafts, chambers, etc., and at all other parts that may be ordered, the masonry is to be built carefully to the curves and forms given by the engineer.

35. All iron steps, floor pieces, guides, grooves, and all other iron work for permanent use, the station plates, will be furnished by the city, and, with the exception of the gate apparatus, shall be built in the masonry wherever, and in the manner directed by the engineer, without extra compensation; but all iron piping that may be needed during the progress of the work to facilitate the construction and setting of the masonry, shall be furnished by the contractor at his own expense; and left in, if so ordered.

36. No mason work of any description is to be laid in the trenches between the first of November and the first of April, except by special permission of the engineer.

37. The greater part of the masonry is to be laid in American cement mortar; but Portland cement is to be used whenever directed. The American cement must be equal in quality to the best Rosendale cement; it must be made by manufacturers of established reputation; must be fresh and very fine ground, and in well made casks. The Portland cement must be of a brand equal in quality to the best English Portland cement To insure its good quality, all the cement furnished by the contractor will be subject to inspection and rigorous tests; and if found of improper quality will be branded, and must be immediately removed from the work; the character of the tests to be det rmined by the engineer. The contractor shall, at all times, keep in store at some convenient point in the vicinity of the work, a sufficient quantity of cement to allow ample time for the tests to be made without delay to the work of construction. The engineer shall be notified at once of each delivery of cement. It shall be stored in a tight building and each cask must be raised several inches above the ground by blocking, or otherwise.

38. Mortar shall be prepared from cement of the quality before described, and clean sharp sand free from loam. These ingredients shall be thoroughly mixed *dry*, in the following proportions: one part, by measure of cement to two parts of sand; and a moderate dose of water is to be afterwards added to produce a paste of proper consistency; the whole to be thoroughly worked with hoes or other tools. In measuring cement, it shall be packed as received from the manufacturer. The mortar shall be freshly mixed for the work in hand, in proper boxes made for the purpose; no mortar has to be used that has become hard or set. Whenever the engineer may order it, the above proportions of cement and sand shall be changed to one part by measure of cement to one part by measure of sand.

39. The concrete shall be formed of sound broken stone, not exceeding two inches at their greatest diameter. All stone in any way larger is to be thrown out. The materials to be cleaned from dirt and dust before being used; to be mixed in proper boxes, with mortar of the quality before described, in the proportion of five parts of broken stone to one part of cement; to be laid immediately after mixing, and to be thoroughly compacted throughout the mass till the water flushes to the surface. The concrete shall be allowed to set for twelve hours, or more if so directed, before any work shall be laid upon it; and no walking over or working upon it shall be allowed while it is setting. The concrete used for backing must be placed and compacted with extreme care, and no water is to be allowed to interfere with its setting. When stone obtained from the excavation is of proper quality, it may be used for making concrete. Whenever ordered by the engineer, the concrete shall be formed of broken stone not exceeding one inch at their greatest diameter, used in the proportion of three parts of broken stone to one part of cement; the mode of mixing, the quality of the materials, and the manner of using, to be the same as above described.

40. The bricks shall be of the best quality of hand-made hardburnt bricks; burnt hard entirely through, regular and uniform in shape and size, and of compact texture. To insure their good quality, the bricks furnished by the contractor will be subject to inspection and rigorous tests, and if found of improper quality, will be condemned; the character of the tests to be determined by the engineer. They are to be culled on the surface before laying, at the expense of the contractor; the engineer to be furnished with men for this purpose by and at the expense of the contractor. Specially moulded bricks, of the shape shown on Sheet No. 12 of the plans, are to be used for the lower corner of the tunnel masonry, of the form shown on Sheet No. 7½.

41. All brick masonry shall be laid with bricks and mortar of the quality before described. No "bats" shall be used except in the outside ring of the covering arch, and in the backing masonry, where a moderate proportion (to be determined by the inspector) may be used, but nothing smaller than half bricks. The bricks to be thoroughly wet just before laying. Every brick to be completely imbedded in mortar under its bottom, on its sides, and on its ends, at one operation. Care shall be taken to have every joint full of mortar. Competent mechanics shall be employed for this work; and for the invert, especially, only the best skilled labor shall be emp loyed.

For all brick masonry the bricks shall be laid to a line, with the beds in the line of the radii of the curves; and with as close joints (not exceeding ¼ inch for either face or arch work) as may be from time to time directed. The inside faces of the joints of the bottom arch, and of the sides, shall be neatly pointed; and those of the upper arch, after the centres have been withdrawn shall have all the mortar projecting beyond the surface of the bricks scraped off not more than fifteen days after the arch has been covered; and shall be pointed and left in a neat condition: all pointing to be done with neat cement.

42. All unfinished work must be racked back, or toothed, as may be directed by the engineer in each case; and before new work is joined to its surface the bricks must be scraped thoroughly clean, and scrubbed with a stiff brush, and well moistened.

43. All stone masonry is to be built of sound stone of quality and size satisfactory to the engineer.

44. Rubble stone masonry shall be made of sound, clean stone of suitable size, quality and shape for the work in hand, and presenting good beds for materials of that class. Care must be taken to have the beds and joints full of mortar, and no grouting or filling of joints after the stones are in place will be allowed. The work must be thoroughly bonded.

Rubble stone masonry is to be used for the side-walls and foundations of the aqueduct when it is built in open trenches, and in any part of the tunnel, or other part of the work where it may be ordered.

In the tunnel, especially, the size and shape of the stone used must be adapted to the spaces to be filled, in order to secure absolutely compact work.

Stone from the tunnel or other excavations may be used, when suitable.

45. A small amount of cut stone masonry is to be used at the upper and lower parts of the shafts; and wherever it may be ordered by the engineer. It is to be built of granite of first quality, free from all defects, and cut to a ¾-inch joint, and to the form indicated on the plans; all exposed surfaces to be finished in fine hammered (six cut) work, of the best description. In measuring the stones when they are not rectangular, the dimensions taken for each stone will be those of a rectangular cubical form which will just enclose the same.

44. Dry rubble stone masonry and paving are to be laid without mortar, and are to be used for the slope walls and for the floor of the channels connected with the waste-weirs, and at any other place that may be designated.

This class of work is to be of stone of suitable size and quality, laid closely by hand, with as few spauls as practicable, in such manner as to present a smooth and true surface.

The work is to be measured in accordance with the depth of stone ordered by the engineer, and no stone will be accepted which has less than the required depth, or which has a feather edge. When this class masonry is ordered to be built directly on the earth, care must be taken to pack the earth solidly about the lower part of the stone and not to leave any vacancies.

44a. Rubble stone masonry shall be made of sound, clean stone of suitable size quality and shape for the work in hand, and presenting good beds for materials of that class. Care must be taken to have the beds and joints full of mortar, and no grouting or filling of joints after the stones are in place, will be allowed.

The work must be thoroughly bonded.

Rubble stone masonry is to be used for the walls of the waste wier chambers and of the channels connected with them, for the side-walls and foundations of the aqueduct where it is built in open trenches, and in any part of the tunnel or other parts of the work where it may be ordered.

In the tunnel, especially, the size and shape of the stone used must be adapted to the spaces to be filled, in order to secure absolutely compact work.

Stone from the tunnel or other excavation may be used when suitable.

44b. Wherever the engineer shall so order, the exposed faces of the rubble masonry are to be made of broken ashlar, with joints not exceeding one inch in thickness; the stones not to be less than 12 inches deep from the face, and to present frequent headers. This face-work to be equal in quality and appearance to the cast face of the western abutment of the bridge over the New York Central and Hudson River Railroad at the Yonkers station.

This face-work is to be paid for by the square foot of superficial area for which it is ordered, in addition to the price paid per cubic yard of rubble masonry.

44c. Rectangular paving is to be used in the waste weirs and at such points of the culverts and other structures connected with them, as may be designated It is to be formed of rectangular stones of various sizes, and so shaped that they can be laid with joints of not more than one-half inch in thickness throughout.

This paving is to be laid in mortar, and it presents when laid, a smooth and even surface.

45. Cut-stone masonry is to be used for the waste weirs, and their appurtenances, for the upper and bottom rings of the shafts, at the places indicated on the plans, and at such other places as may be designated by the engineer.

All cut-stone is to be first-class granite of approved quality, free from all defects, and uniform in color.

The stones shall be cut to exact dimensions, and all angles and arrises shall be true, well defined and sharp.

All beds, builds and joints are to be dressed, for the full depth of the stone, to surfaces allowing of a ⅜-inch joint at most. No plug-hole of more than 6 inches across or nearer than 3 inches from an arris is to be allowed, and in no case must the aggregate area of the plug-holes in any one joint exceed one-quarter of its whole area.

The stone shall be laid with ⅜-inch joints, and all face-joints shall be pointed with mortar made of clear Portland cement, applied before its first setting. All joints to be raked out to a depth of one inch before pointing; the cost of pointing to be included in the price bid for cut stone masonry.

The exposed faces of the cut stone are to be finished in various ways, in accordance with the various positions in which they are placed, as hereinafter mentioned, or with the directions given by the engineer from time to time.

For the outside of the waste weir chambers, where exposed, and for the copings, it is intended that the cut-stone shall be left with its rock face. All the arrises inclosing the rock face, must be pitched to a true line, and no projection on said faces must exceed two inches. A chisel draft, not less than 1½ inches, to be cut at the corners of the buildings, at the expense of the contractor.

Upon the inside of the waste weir chambers, except where otherwise specified or directed, the faces of the stones are to be rough pointed.

The faces where the gates are to be fastened, the exposed faces of the gate openings and of the voussoirs, the grooves, cavities and recesses and any other surface that may be designated by the engineer, are to be finished in fine hammered (six cut) work.

The rock faces, and the rough pointed and fine hammered surfaces, must be equal in quality and appearance to those on the sample in the office of the Chief Engineer.

Headers must be used wherever shown on the plans or wherever directed. The tails of the headers must project at least one foot beyond the adjoining stones, and are to be paid for at the same price as the class of masonry into which they are imbedded.

In measuring cut stone masonry where the stones are not rectangular, the dimensions taken for each stone will be those of a rectangular cubical form which will just enclose the same.

The price stipulated herein per cubic yard of cut stone masonry laid, is to include the cost of cutting the joints and of preparing the rock faces (including the chisel drafts,) of cutting all grooves, holes and recesses, and of building into the masonry and in fastening to it all iron work and the station plates.

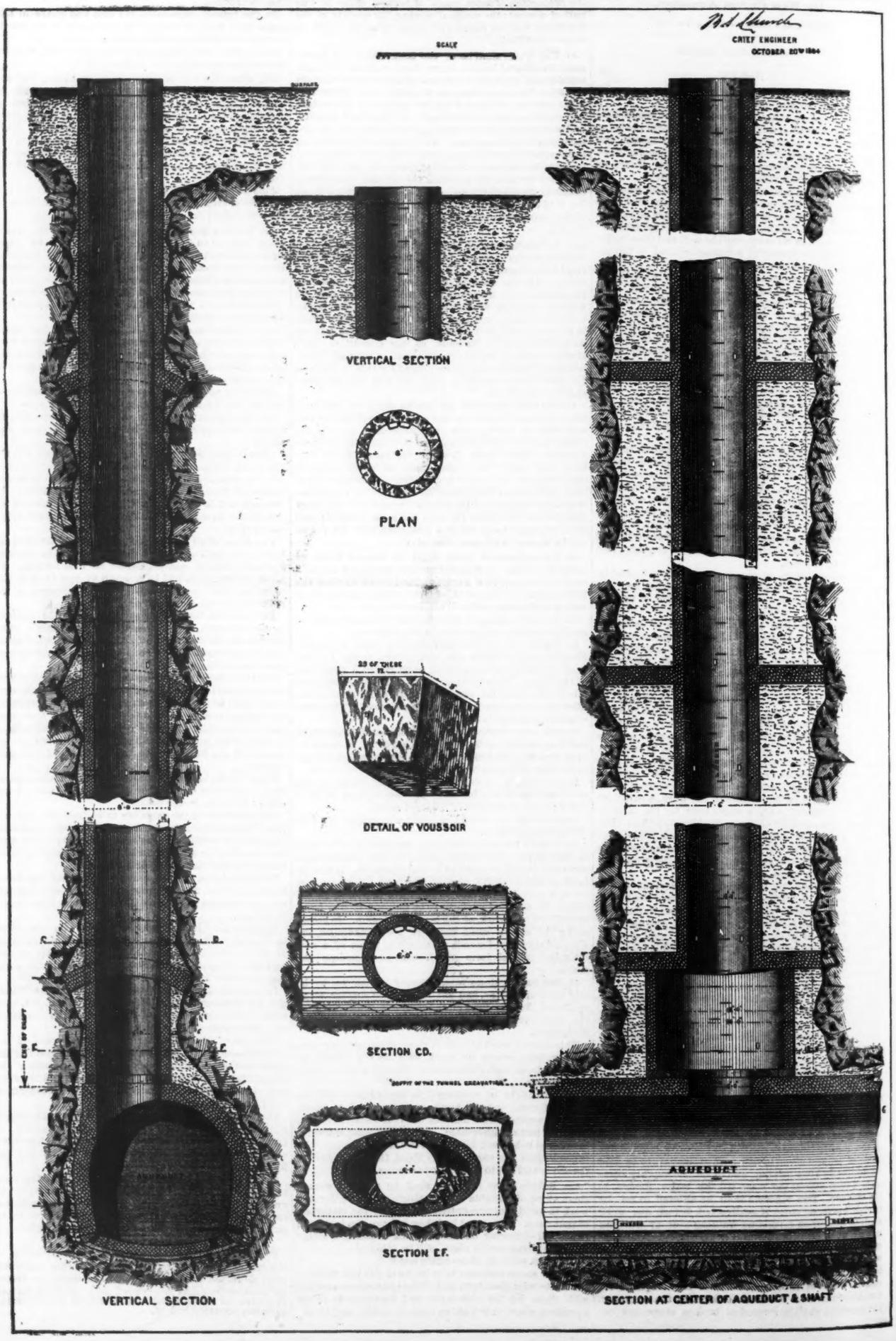
45a. In addition to the price per cubic yard herein stipulated to be paid for cut stone masonry, a price is to be paid for each square foot of rough pointed surface. Also a price for each square foot of surface finished in fine hammered (six cut) work.

46. The city will furnish station plates, and the contractor is to fasten them in the manner directed by the engineer. The number and position of these plates cannot be indicated in advance, but there is not to be more than one for each 500 feet of the aqueduct.

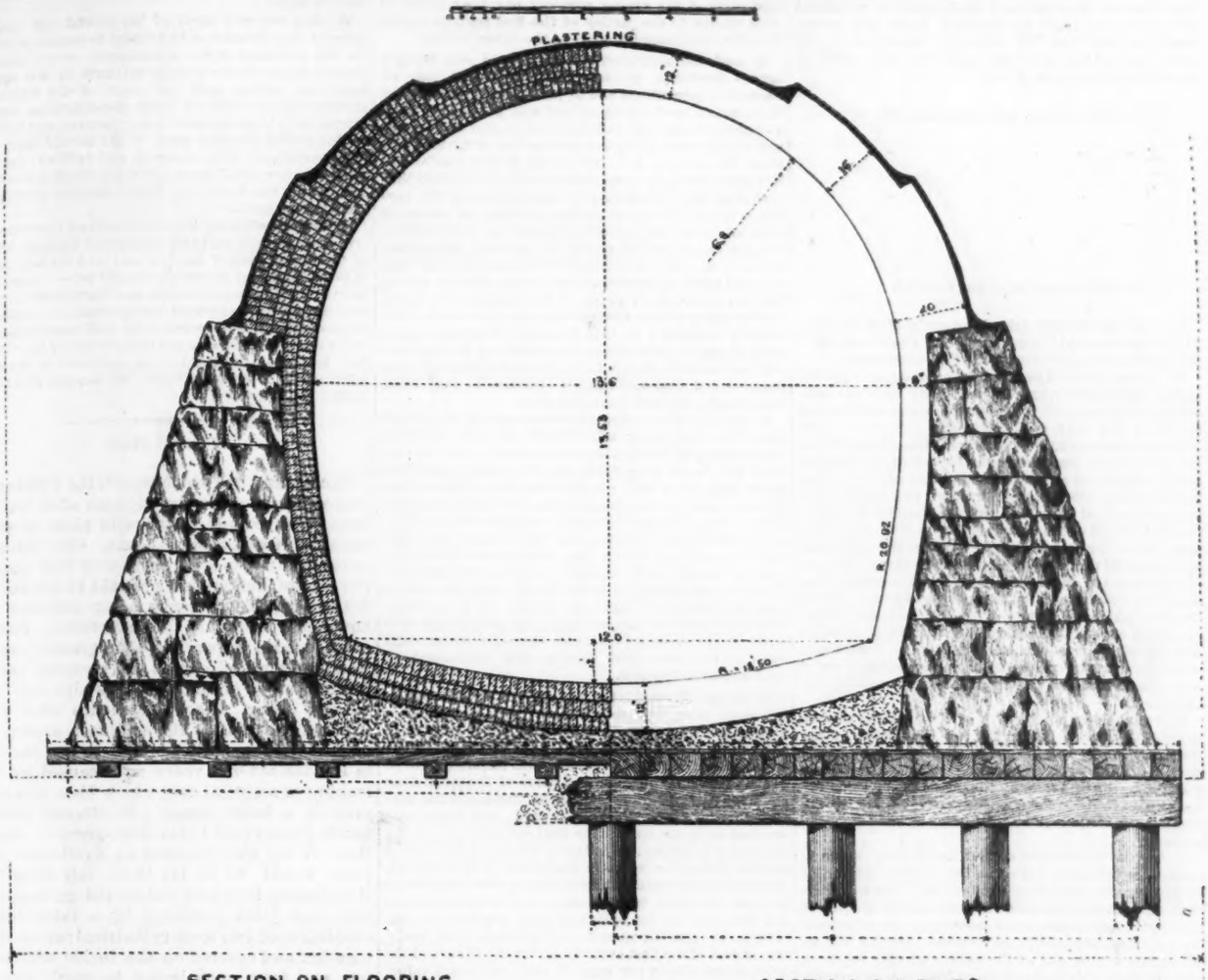
GENERAL CLAUSES.

47. At his own expense, and under the direction of the engineer, the contractor is to clear the aqueduct from all refuse and rubbish, and to do about the shafts all grading that may be ordered; to do all ditching and diverting of streams, and leave in neat condition the grounds occupied by him.

NEW CROTON AQUEDUCT. GENERAL PLAN OF SHAFT.



NEW CROTON AQUEDUCT. CROSS-SECTION ON PILES AND FLOORING.



SECTION ON FLOORING
FIG. 1

SECTION ON PILES
FIG. 2

48. The contractor is to give all facilities to the city or to other contractors for performing work adjoining his own, and any difference which may arise between two contractors in regard to their adjoining work is to be adjusted by the engineer, whose decision is to be final in the matter.

49. All lines and grades are to be given by the engineer, who may change them from time to time as he may be authorized and directed by the said Aqueduct Commissioners, even to the extent of lowering or raising the grade line of the aqueduct, or of ordering vertical or side drifts.

50. The stakes and marks given by the engineer, and the troughs for the plumb lines, must be carefully preserved by the contractor, who must give to the engineer all necessary assistance and facilities for establishing the benches and plugs, and for making measurements.

51. The plans and specifications are intended to be explanatory of each other, but should any discrepancy appear, or any misunderstanding arise as to the import of anything contained in either, the explanation and decision of the Chief Engineer shall be final and binding on the contractor; and all directions and explanations required, alluded to, or necessary to complete any of the provisions of these specifications, and give them due effect, will be given by the engineer.

G. And it is further agreed that if the work, or any part thereof, or any material brought on the ground for use in the work, or selected for the same, shall be condemned by the engineer as unsuitable, or not in conformity with the specifications, the contractor shall forthwith remove such materials and rebuild or otherwise remedy such work, as may be directed by the engineer.

H. No claim for extra work shall be made unless before the performance of such extra work the said Commissioners shall have first authorized, in writing, such extra work; and shall have also first certified in writing, for each and every order, that it is in their opinion for the public interest that such extra work be done; stating in such certificate their reasons therefor; nor unless before the performance of such extra work the price or prices to be paid therefor shall likewise first have been agreed upon, in writing, between the said commissioners and the contractor, and done in obedience to a written order from the Chief Engineer, given before the performance of such extra work.

The aggregate price to be paid for extra work authorized or ordered under and by virtue of the aforegoing provision of this contract, shall not exceed the sum of five thousand dollars on any one order.

And the said party of the second part further agrees that if he the party of the second part, and the said commissioners are or may be unable to agree, as aforesaid, upon the price or prices to be paid for any extra work which may be authorized as aforesaid, he the said party of the second part will not in any way interfere with or molest such other person or persons as the said commissioners may employ to do such extra work; and that he, the said party of the second part, will suspend such part of the work herein specified, or will carry on the same in such manner as may be ordered by the said engineer, to afford all reasonable facilities for doing such extra work; and no other damage or claim by the said party of the second part shall be allowed therefor, other than an extension of the time specified in this contract for the performance of said suspended work as much as the same may have been, in the opinion of the engineer, delayed by reason of the performance of such extra work.

I. And the said party of the second part hereby further agrees to give his personal attention constantly to the faithful prosecution of the work, and not to assign or sublet the work, or any part thereof, without the previous written consent of the Aqueduct Commissioners indorsed on this agreement, but will keep the same under his personal control. And the said party of the second part further agrees that he will not assign, by power of attorney or otherwise, any of the moneys payable under this agreement, unless by and with the like consent of said commissioners, to be signified in like manner. And the said party of the second part further agrees that no right under this contract, nor to any moneys due or to become due hereunder, shall be asserted against the Aqueduct Commissioners, or any person acting under them, or the Mayor, Aldermen or Commonalty of the City of New York, or any department, officer or officers thereof, by reason of any so called assignment, in law or equity, of this contract, or any part thereof, unless such assignment shall have been authorized by the written consent of said Aqueduct Commissioners indorsed on this agreement; that no person other than the party signing this agreement, as the party of the second part hereto, now has any claim hereunder; that no claim shall be made excepting under this specific clause of this agreement, or under paragraph 8 of this agreement, by any person whomsoever; and that the said party of the second part will punctually pay the workmen who shall be employed on the aforesaid work in cash current, and not in what is denominated store pay.

J. The Aqueduct Commissioners reserve the right of suspending the whole or any part of the work herein contracted to be done, if they shall deem it for the interest of the City of New York so to do, without compensation or allowance to the contractor for such suspension, other than extending the time for completing the work as much as it may have been delayed by such suspension.

And if the said work shall be delayed for the reason that the parties of the first part do not own, or have not obtained possession of, the land on which the same is to be performed, then and in that case, and in every such case, the party of the second part shall be entitled to so much additional time wherein to perform and complete this contract on his part, as the said engineer shall certify in writing to be just. But no allowance, by way of damages, shall be made for such delay.

K. And the said party of the second part further agrees to employ only competent, skillful, men to do the work; and that whenever the engineer shall inform said party of the second part in writing that any man on the work is in his opinion incompetent, or unfaithful, or disorderly, such man shall be discharged from the work, and shall not again be employed on it.

L. And the said party of the second part further agrees to commence the work herein required to be done, within twenty days after the signing of this contract, and that the rate of progress shall be such that:

1st. In eighty days from the execution of the contract at least one hundred and twenty vertical feet of the full excavation of each shaft shall be excavated, and each portal shall be prepared ready for commencing the heading; and that in every thirty subsequent days, at least sixty additional feet of each shaft shall be ex-

cavated, until the completion of the shaft excavation"

2nd. In each and every month, commencing sixty days from the time that each shaft must be excavated and each portal must be prepared under this agreement, not less than the following proportion of the total length of the headings adjoining said shaft or portal shall be excavated, viz.:

$\frac{1}{25}$ for the headings adjoining shaft No. 19

$\frac{1}{\ldots}$ " " " " " "

$\frac{1}{\ldots}$ " " " " " "

$\frac{1}{\ldots}$ " " " " " "

$\frac{1}{24}$ for the heading adjoining a portal.

3rd. And thirty-three calendar months after the date of the execution of the contract, the whole work shall be completed in accordance with this agreement.

M. In case the said party of the second part shall fail to fully and entirely, and in conformity with the provisions and conditions of this agreement, perform and complete the said work, and each and every part and appurtenance thereof, within the time hereinbefore limited for such performance and completion, or within such further time as may be allowed by the Aqueduct Commissioners for such performance and completion, the said party of the second part shall and will pay to the said parties of the first part the sum of one thousand dollars for each and every day that the said party of the second part shall be in default; which said sum of one thousand dollars per day is hereby agreed upon, fixed, and determined by the parties hereto, as the damages which the parties of the first part will suffer by reason of such default, and not by way of penalty. And the said parties of the first part may deduct and retain said sum of one thousand dollars per day out of any moneys that may be due or become due under this agreement.

N. But neither an extension of time for any reason beyond that fixed herein for the completion of the work, nor the doing and acceptance of any part of the work called for by this contract, shall be deemed to be a waiver by the said Commissioners of the right to abrogate this contract for abandonment or delay, in the manner provided for in the paragraph marked P in this agreement.

O. And the party of the second part hereby agree to receive the following prices as full compensation for furnishing all materials not found in the work (except the iron and the station plates) and for labor and use of tools and other implements necessary for executing the work contemplated in this contract; also for all loss or damage arising out of the nature of the work, or from the action of the elements, or from any unforeseen obstructions or difficulties which may be encountered in the prosecution of the work; and for all risks of every description connected therewith also, for all expenses incurred by, or in consequence of, the suspension or discontinuance of said work, as herein specified: and for well and faithfully completing the work, and the whole thereof, according to the plans and specifications and the requirements of the engineer under them, to wit:

(Detailed bid inserted here.)

P. The said party of the second part further agrees that if the work to be done under this agreement shall be abandoned, or if the conditions as to the rate of progress hereinbefore specified are not fulfilled, or if this contract shall be assigned by the party of the second part otherwise than as is hereinbefore specified; or if at any time the engineer shall be of opinion and shall so certify in writing to the said commissioners that the said work or any part thereof is unnecessarily or unreasonably delayed, or that the said contractor is violating any of the conditions or covenants of this contract, or executing said contract in bad faith, or if the work to be done under this contract be not fully and entirely completed within the time herein stipulated for its completion, the said commissioners shall have the power to notify the aforesaid contractor to discontinue all work, or any part thereof, under this contract, and thereupon the said contractor shall discontinue said work, or such part thereof as said commissioners may designate, and the said commissioners shall thereupon have the power to place such and so many persons, and obtain by purchase or hire such materials, animals, carts, wagons, implements and tools by contract or otherwise, as said commissioners deem necessary, to complete the work herein described, or such part thereof, and to procure materials for the completion of the same, and to charge the expense of said labor and materials, animals, carts, wagons, implements and tools to the aforesaid contractor; and the expense so charged shall be deducted and paid by the parties of the first part out of such moneys as either may be due, or may at any time thereafter become due to the said contractor under and by virtue of this agreement, or any part thereof; and in case such expense is less than the sum which would have been payable under this contract if the same had been completed by said contractor, then the said party of the second part shall be entitled to receive the difference, and in case such expense shall exceed the last said sum, then the said party of the second part will pay the amount of such excess to the parties of the first part, on notice from the said commissioners of the excess so due.

Q. And the said party of the second part further agrees, during the performance of the work to take all necessary precautions and to place proper guards for the prevention of accidents, and will put up and keep at night suitable and sufficient lights, and will indemnify and save harmless the said parties of the first part from all damages and costs to which they may be put by reason of injury to the person or property of another resulting from negligence or carelessness in the performance of the work, or in guarding the same; or from any improper materials used in its construction, or by or on account of any act or omission of the said party of the second part, or the agents thereof. And the said party of the second part hereby further agrees that the whole, or so much of the moneys due under and by virtue of this agreement as shall or may be considered necessary by the Aqueduct Commissioners, shall or may be retained by the parties of the first part until all suits or claims for damage as aforesaid have been settled, and satisfactory evidence to that effect furnished to the said commissioners.

S. And it is further agreed by the party of the second part, that said party will furnish the said Aqueduct Commissioners with satisfactory evidence that all persons who have done work, or furnished materials, under this agreement, and who may have given written notice to said commissioners before or within ten days after the final completion and acceptance of the whole work under this contract, that any balance for such work or materials is due and unpaid, have been fully paid or satisfactorily secured. And in case such evidence is not furnished as aforesaid, such amount as may be necessary to meet the claims of the persons aforesaid may be retained from the money due said party of the second part under this agreement, until the liabilities aforesaid shall be fully discharged, or such notice withdrawn.

T. In order to enable the said contractor to prosecute the work advantageously, the engineer shall, once a month, make an estimate in writing of the amount of work done, and of the value thereof, according to the terms of this contract. The first such estimate shall be of the amount or quantity and value of the work done since the party of the second part commenced the performance of this contract on his part. And every subsequent estimate (except the final one) shall be of the amount or quantity and value of the work done since the last preceding estimate was made. And such estimates of amount and quantity shall not be required to be made by strict measurements, or with exactness; but they may, at the option of said engineer, be approximate only. Upon each such estimate being made, the parties of the first part will pay to the parties of the second part ninety per cent. of such estimated value. And whenever in the opinion of the engineer the party of the second part shall have completely performed this contract on his part, the said engineer shall so certify, in writing, to the Aqueduct Commissioners; and in his certificate shall state, from actual measurements, the whole amount of work done by the said party of the second part, and also the value of such work under and according to the terms of this contract. And on the expiration of thirty days after the acceptance by said commissioners of the work herein agreed to be done by the party of the second part, the said parties of the first part will pay to the said party of the second part, in cash, the amount remaining after deducting from the amount or value contained and stated in the last mentioned certificate, all such sums as shall theretofore have been paid to the said party of the second part under any of the provisions in this contract contained; and also all such sum or sums of money as by the terms hereof they are or may be authorized to reserve or retain; provided that nothing herein contained shall be construed to affect the right hereby reserved of the said commissioners to reject the whole or any portion of the aforesaid work, should the said certificate be found, or known to be, inconsistent with the terms of this agreement, or otherwise improperly given.

U. And it is hereby expressly agreed and understood by and between the parties hereto that the said parties of the first part, their successors and assigns, shall not, nor shall any department or officer of the City of New York be precluded or estopped by any return or certificate made or given by any engineer, inspector, or other officer, agent, or appointee of said Aqueduct Commissioners, or of said parties of the first part, under or in pursuance of anything in this agreement contained, from at any time showing the true and correct amount and character of the work which shall have been done and materials which shall have been furnished, by the said party of the second part, or by any other person or persons under this agreement.

V. It is further expressly understood and agreed by and between the parties hereto, that the action of the engineer, by which the said contractor is to be bound and concluded according to the terms of this contract, shall be that evidenced by his final certificate; all prior partial payments being made merely upon estimates subject to the correction of such final certificate; which final certificate may be made without notice to the contractor thereof, or of the measurements upon which the same is based.

W. And the said party of the second part further agrees not to demand or be entitled to receive payment for the aforesaid work or materials, or any portion thereof, except in the manner set forth in this agreement; nor unless each and every of the promises, agreements, stipulations, terms and conditions herein contained to be performed, kept, observed, and fulfilled on the part of the said party of the second part, has been performed, kept, observed, and fulfilled; and the said engineer shall have given his certificate to that effect, and the Aqueduct Commissioners shall have accepted the work.

In witness whereof, the said Aqueduct Commissioners have hereunto set their hands and seals on behalf of the said parties of the first part, and the said party of the second part has also hereunto set——hand and seal; and said commissioners, and party hereto of the second part, have executed this agreement in triplicate; one part of which to remain with said commissioners, one other to be filed with the Comptroller of the City of New York, and the third to be delivered to the said party hereto of the second part; the day and year herein first above written.

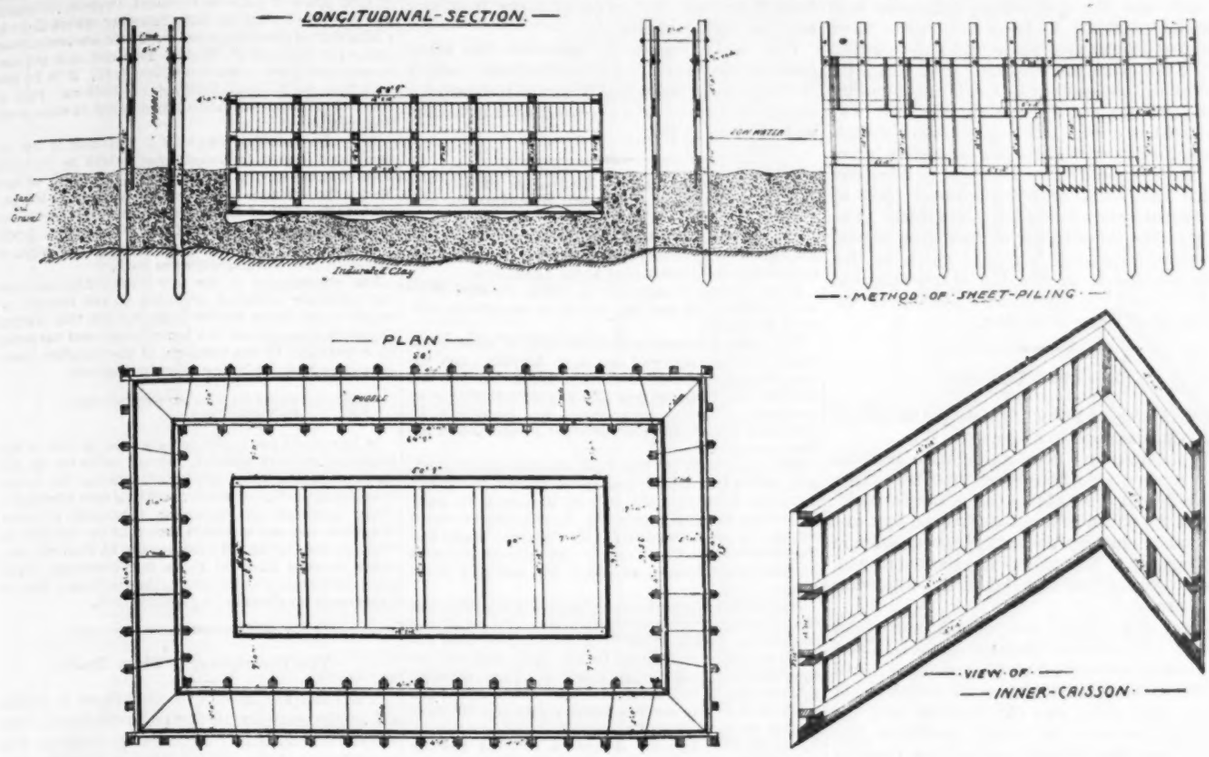
Natural Gas.

The natural gas which caused the Pittsburgh explosions is perfectly odorless after having been conveyed any distance in pipes or after standing twenty-four hours. One engineer urges that no pipes carrying over four ounces per square inch pressure should be allowed in the streets, this pressure being sufficient for any house and most manufactories. Frozen earth is more impervious than granite, and a leak underground causes the escaping gas to follow a water or artificial gas-pipe into the nearest cellar, where it explodes when ever exposed to a light. The engineer expects to next hear of an explosion in a sewer, like one in London several years ago, caused by the leaking of artificial gas, which blew up half a mile of a large sewer. He thinks that it needs greater care to lay high-pressure mains than to lay the roadbed of a railroad. His plan would be to lay them only along the river banks, four feet below the surface, and have each joint protected by a safety-jacket consisting of two semi-cylindrical parts bolted together and covered on the inside with rubber, and from each jacket he would have a pipe run up to a waste-pipe just below the surface, which should have escape pipes running up to the top of a telegraph pole at each street corner. Another expert lays the breakages entirely to the cold weather, which has stripped the thread on the sleeves, thus leaving a space for the gas to escape. He would put on discs or expansion joints every 300 feet of the long lines, and says that their use in the oil regions has prevented explosions during the many years in which natural gas has been in use.

A GUN AS AN ENGINE. In the course of a lecture on the conversion of heat into useful work, Mr. W. Anderson remarked that a gun was the simplest machine for the conversion of heat into work. It was a single-acting engine which applied its work at one stroke, and did not work in a continuous series of cycles like most engines. The new pattern 10 inch breech-loading rifled gun which he selected as an example weighed 27 tons, and was 26 feet 10 inches long, and discharged a shot weighing 500 pounds. The charge of 300 pounds of pebble gunpowder was capable of producing work equal to 73,658 foot tons, of which, on the discharge of the gun, 23,685 foot tons were expended in external work—the energy imparted to the shot in its forward motion, etc., 1,581 foot tons in internal work—producing a rotary motion of the shot, etc., and the remaining large balance in communicating to the metal of the gun the molecular motion which became apparent in the form of heat.

ENGINEERING NEWS three months for One Dollar.

COFFER-DAM AND CRIB OF THE POINT PLEASANT BRIDGE, W. VA.



Coffer-dams and Cribs of the Point Pleasant, W. Va. Bridge.

BY COL. WM. M. PATTON, C. E.

During the summer of 1881, the author, while in charge of a locating party on the proposed extension of the R. & A. R. R., to the Ohio River, was ordered by Col. H. D. Whitcomb, Chief Engineer, to proceed to Point Pleasant, W. Va., at the juncture of the Ohio and Kanawha Rivers, and to make surveys for a proposed bridge crossing over the Ohio between Point Pleasant and Pomeroy, a town about 17 miles above.

The banks of the river between the points named were accordingly surveyed, and cross-sections taken at all seemingly favorable points, six such points being found in the 17 miles. Borings were made with an iron rod 1 inch in diameter, made in sections and coupled together with sleeve connections; two wooden horses, two mauls and four men constituted the outfit. The rod was forced down by driving and constant turning and in this way depths of 25 and 30 feet were reached through sand, gravel and clay. The result was unsatisfactory in giving no evidence of the thickness and the nature of the strata passed through.

The surveys and approximate estimates soon developed the fact that only two crossings were really available, one through Point Pleasant and the other about 8 miles above. Current observations were taken at these two points in accordance with the requirement of the U. S. Government. For this purpose floats were used, from 4 to 6 feet long, and weighted at the bottom so as to float vertically and with but a slight projection above the surface. These floats were placed at intervals of 50 feet in the width of the river; and in the passage, from a point ½ mile above to ½ mile below the proposed crossing, angles were taken to the float, from two instruments, at intervals of one half minute. Soundings were also obtained at points 50 feet apart across the stream and on cross-sections 100 feet apart for a mile above and below the crossing. Considerations other than those of economy, finally lead to the adoption of the line through the town, at a point about ½ mile above the mouth of the Kanawha.

At the site selected the banks of the Ohio River rise from 40 to 50 feet above low water, and the width of the stream is 1370 feet, with 5 feet of water at extreme low water. The bottom was gravel, from 5 to 14 feet deep, and then hard, dry, compact clay of an undetermined depth. The design adopted included six piers, two on land and four in the water; there were thus three spans of 250 feet each, one of 420 feet and one of 200 feet. These piers were to be built about 90 feet above low water, that being the height required by the U. S. Government for the channel spans; they were all through spans.

The plans were matured and then approved by S. M. Seymour, Chief Engineer O. C. R. R. and General Samuel Thomas, President. The masonry contract was awarded to G. S. Casement & Co., and the foundations were to be put in by the railroad company. All preparations were made to start work in February, 1882, but owing to an unprecedented continuance of high water nothing was done, except the building of the land piers, until August 16, 1882. Some piles were then driven for the coffer-dam of Pier No. 5, but owing to the continual interruptions from high water little was accomplished until Oct. 9, on which latter date the river work was fairly commenced.

The accompanying illustrations show the plan, elevations and sections of the coffer-dam and inner crib used. The main piles were driven in two rows, with about 4 feet between piles and 5½ feet between rows, to these were bolted 6 × 12 inches wale-pieces, as shown in the sketch; these were pushed down by means of battens spiked to them and when at the proper depth the battens were spiked to the top wale-piece. A double course of 3-inch sheet-piling was then driven, using heavy mauls; the main piles were driven through the gravel and sand into the clay; the sheet-piling was driven only about 12 or 18 inches into the gravel. The space between the planking was then filled with puddle. In all cases the driving of piles and sheet-piling and the filling with puddle was carried on simultaneously, so that in a day or two after the driving of the last main pile the dam was ready to be pumped out.

The inner crib was constructed by setting horizontal timbers enclosing the desired space, after the coffer-dam was pumped out, and supporting these at intervals by short posts and then spiking 3-inch planking on the outside. The bottom was made of two courses of 12 × 12 inch timbers bolted together and the lowest course was bevelled to form a cutting-edge; the outside planking extended below and continued the cutting edge. Cross braces were inserted and the work of excavation commenced. As the material was removed the crib was weighted by placing large building stone on platforms attached to the crib, which latter accordingly sunk as fast as the material was taken out. The gravel was hoisted out in large boxes suspended a little in rear of the center of gravity and prevented from dumping by a detachable chain connecting with the hoisting rope. The water was kept down by centrifugal pumps, one throwing a stream 6-inch in diameter was generally found more than ample to do the work required.

The advantages to be gained in using the inner crib are;—the reduction to a minimum of the amount of material to be excavated; it makes it possible to keep the bottom of the sheet-piling always covered and thereby prevents undermining and an inflow of material under the dam; the space between the crib and the dam can be kept full of material in case of any trouble with the dam; and finally the coffer-dam is materially smaller than it would be if the saturated soil was allowed to take its natural slope within the dam. The author considers it an economical method of constructing foundations when the depth of water is inconsiderable, not over 15 feet, and the distance to be sunk does not exceed 25 or 30 feet. Beyond these limits the expense will increase in rapid ratio with the depth. Very little machinery or plant of any kind is required, and, as the crib prevents the points of the piles from being exposed at any time, there is no danger in excavating below the foot of the

piles. At least 6 feet should be left between the crib and the coffer-dam, otherwise it is sometimes difficult to keep this space filled when any influx takes place under the cutting edge of the crib; the material lowers rapidly between the two and unless this surrounding space is filled promptly, the outside dam will be seen to give way. The space left for puddle need not exceed 3 or 4 feet, and even when this has been reduced to 18 inches or 2 feet the author has found no more leakage than at other points when it was 5 or 6 feet thick. The strain on the inner lining of the dam is also less where the puddle is not so thick, as this strain seems to be augmented by the weight of the filling and the apparent tendency of the clay, to swell when saturated.

The Basic Process.

Jacob Reese, of Pittsburgh, writes as follows to the Chattanooga *Tradesman:*

"In the Iron and Steel Association Bulletin I find a very able article on 'Southern Iron in the North,' in which these words occur: 'As yet the South has not discovered any one fit to make steel by any fully developed and tried process.' The article is credited to you. I therefore ask you to publish the following statement of facts:

"Good steel should not contain more than 0.020 of phosphorus. Bessemer Steel should not contain over 0.100 of phosphorus. Until 1880 the method employed to produce iron fit for the best steel was the Catalan and the puddling process, in which operation the phosphorus was sweated out of the iron by liquation. Bessemer failed to eliminate the phosphorus by liquation, and was compelled to use non-phosphoretic iron to produce his steel. Or, in other words, his process being unable to take any phosphorus out of the metal, he was restricted to the use of metal which would not have over one-tenth of 1 per cent (0.100) of phosphorus in the finished steel. The open hearth process is subject to the same conditions, and will not dephosphorize. As far as these processes are concerned, it is true that the ores of the South are unfit for the manufacture of steel.

"Phosphorus cannot be eliminated from iron or steel while the molten metal is held in the presence of an acid slag or carbonic oxide. The acid slag and CO are both present in the blast furnace, hence dephosphorization does not and cannot take place in a blast furnace. The acid slag and the CO are both present in the Bessemer and the open hearth process, hence phosphorus cannot be eliminated by them. In the basic process, I dispense with the acid slag, and in place thereof I use a basic slag, and after blowing the metal until the silicon and carbon are eliminated I then continue the blow in the absence of carbon, when the phosphorus is oxidized to phosphoric acid and is held in the slag as a phosphate. By this process I am enabled to get a most pure iron, as the following analysis shows:

	Pig Metal.	Basic Steel.
Carbon	3.20	0.09
Silicon	1.10	0.00
Phosphorus	2.43	1.02
Sulphur	0.24	0.08

The basic process may be conducted either in a Bessemer converter, in an open hearth, or in any other suitable vessel. In the basic open hearth, where there is extraneous fuel used to keep the metal fluid, any grade of metal may be used, but I prefer a metal which does not contain over 1 per cent. of phosphorus; but in the basic Bessemer process the phosphorus is used as a calorific power, as a means of keeping the metal fluid. So that it is desirable to have from 2½ to 3 per cent. of phosphorus in the pig iron. Now if the ores will not furnish that much phosphorus, then I use a quantity of the waste slag from the converter, which is high in phosphorus, instead of lime, in the blast furnace, and by this means am able to produce a pig having from 2½ to 3 per cent. of phosphorus from any kind or quality of ores.

The basic process is therefore the great need of the South. By it a first-rate quality of steel can be made and put on ship board for export at a cost not to exceed $25 per gross ton and possibly at $20.

The Transcontinental Railroads of North America from a French Standpoint.

A report, made by M. Fabre, to the *Société de geographie commerciale de Paris* speaks as follows of the transcontinental railways of North America:—

In the history of railroads in North America there are two dates, 1831 and 1869, which in importance outrank all others.

The year 1831 witnessed the first train of passengers, drawn by the agency of steam, in America; and the year 1869, the first transcontinental train. On this last date, the Pacific Ocean was tied to the Atlantic by an iron-way 3,261 miles long; and it was possible to go from New York to San Francisco in 6½ days, and in the same carriage.

The 12½ miles of the first year, 1831, have multiplied; and, after a half century has rolled around, the grand American Republic is able to point proudly to its many and widely diverging railroads. In 1883, 120,600 miles of railway cut up the territory of the different States and Territories of the Union: while the mileage of roads operated in all Europe, on Jan. 1, 1883, was only 110,500 miles.

The one line across the continent did not suffice, and the Americans were not slow in seeing the utility of a second line, parallel to the first. This second road was located north of the Union Pacific R. R., and not far from the frontier of British America. It was, perhaps, thought that by this enterprise they would retard the construction of a similar interoceanic line by their British-American neighbors.

But, British America desired a railroad passing through its own territory alone, and, about 1870, the Colonial Government began to formulate this idea. British Columbia sought an entrance into the federal fold, on the condition that it should be united, within ten years to Ottawa, the Capital of the Dominion of Canada; this demand then became an excellent pretext for giving a definite shape to the railway project, and as a consequence, a transcontinental American railway, the most northerly that perhaps will ever be built, was commenced in earnest. But we do not find in this enterprise the rapidity of execution which characterized the work of the Yankees, who decreed that a railway should be built on July 1, 1862, commenced work in 1864, and on May 10, 1869 had finished the 1,855 miles of railroad which separated Omaha from San Francisco; and they completed their railway seven years ahead of the date fixed by the concession.

If British America has not yet finished its one interoceanic line, the United States has actually three lines, entirely completed; the two we have already mentioned and a third which traverses the southern end of the American continent and unites the Pacific Ocean to the Gulf of Mexico. This is the Southern Pacific opened within the year.

This new railroad has San Francisco for its point of departure, then goes southeast through the State of California; at Mojave Junction it intersects the line running from St. Louis, and then traverses the semi-tropical portion of California, on the Rio Colorado. At Benson there is a branch towards Guaymas, on the Gulf of California: at Deming, it meets the Atchison, Topeka, and Santa-Fe; at El Paso, it joins the Mexican Central R. R., which runs into Mexico through the State of Chihuahua. This railroad, diverging more and more to the South, meets at San Antonio, the International R. R. which traverses the Mexican State of Cahahuila and by way of Laredo reaches the capital of Mexico. The line touches successively Houston, Vermillionville and finally New Orleans.

The principal stations on the Southern Pacific R. R., with their distances is as follows:

San Francisco.	MILES.
Mojave	382
Los Angeles	482
Yuma	721
El Paso	1,366
Lozier	1,644
San Antonio	1,918
Houston, (Galveston)	2,134
Vermillionville	2,351
New Orleans	2,495

This total distance of 2,495 miles is run in five days.

The railroad from New York to San Francisco is now well known in all its details, but we give some of the distances separating stations, as follows:

	MILES.
New York to Chicago	910
Chicago to Omaha	489
Omaha to Ogden	1,030
Ogden to San Francisco	824

The third transcontinental line, located to the north, is the Northern Pacific Railroad, which was finished and opened in 1883. Its point of departure is St. Paul, on the upper Mississippi. After running a distance of 1,907 miles it ends at Portland, Oregon. A branch line ties it to Duluth on Lake Superior, where there is a lake port of great importance. There are two express trains per day from St. Paul to Portland, and the passenger rate is $95, or $126 from New York. It is by this line that the famous Yellowstone National Park is reached, an immense natural park equal in area to all Switzerland.

As to the Canadian Pacific R. R., this line is not yet completed, but it is hoped that it will be formally opened in the spring of 1886. From Montreal to Port Moody the distance is 2,893 miles: it traverses the important Province of Manitoba and is united by various lines to the railway system of the United States. It will cross the Rocky Mountains by a pass not exceeding in elevation 5,300 feet above the sea level.

The construction of the new transcontinental lines has naturally attracted attention to the reduced receipts of the Union Pacific R. R. Co.; but this diminution is in consequence of a war of rates, and not owing to a decrease in the tonnage of merchandise transported, as is shown by the following figures:

1882,	732,791,054	tons carried one mile.
1883,	745,989,015	" " "

In Europe no one is able to form even an idea of this frightful, ruinous warfare, carried on by the 500 railway companies, great and small, forming the railway systems of the States, some operating only a few miles, other corporations managing thousands of miles. What this rate war means is shown by the fact that the Wabash, the Chicago, Milwaukee and St. Paul and many other western lines, at times sell passenger tickets good for 500 miles travel for $1., that is "more than 800 kilometres for 5 francs."—*Le Genie Civil.*

The Pennsylvania Slate Trade.

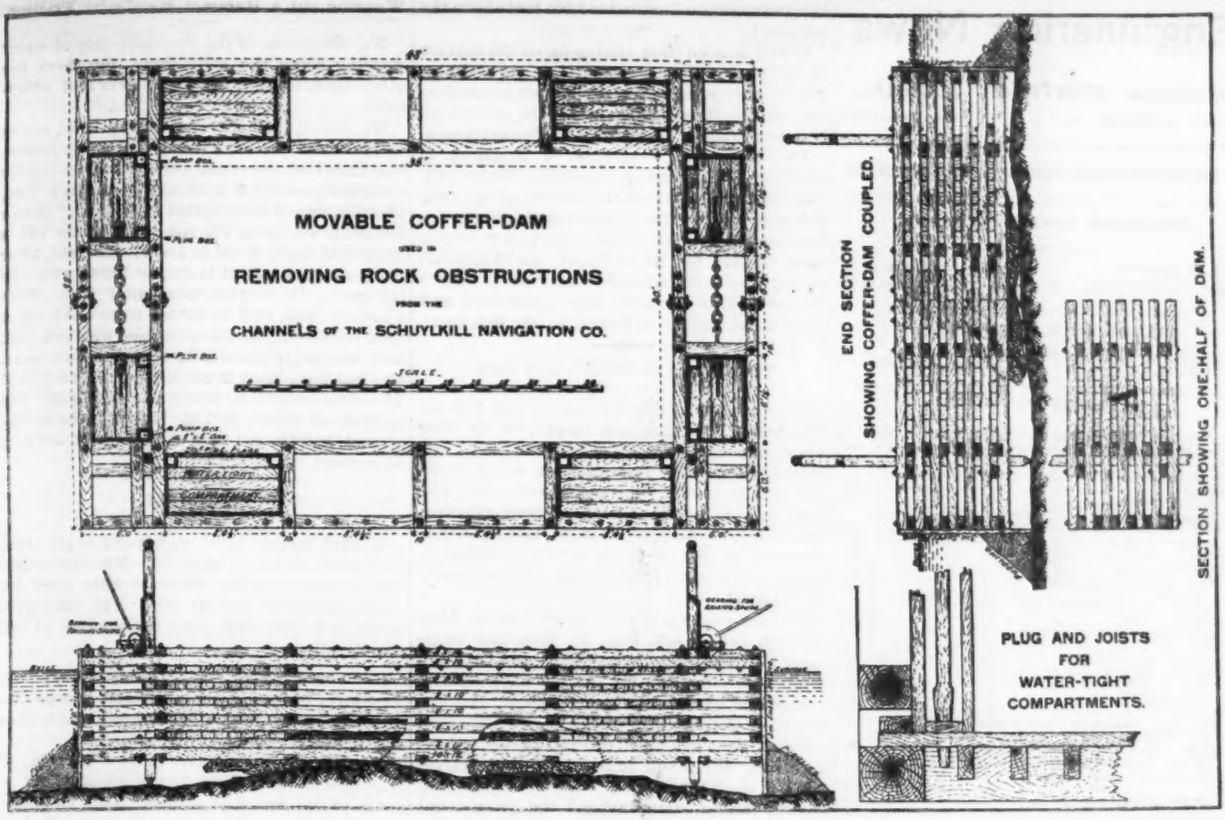
The slate shipments of 1884 show a falling off as compared with the previous year. Slate operators say it is yet too early to speak with confidence of the coming season, but the feeling prevails that bottom rock has been reached and then an improvement will surely follow.

The shipments from the Slatington section for the year 1884 were as follows: Roofing slate, 104,000 squares; school slate, 36,079 cases; flagging, 30,517 pieces, 1,489 cases and 25 cars; blackboards, 4,130 cases; mantels, 28 pieces and 19 cases; hearths, 33 cases; small slate and shaven slate, 11 cars. The wages paid per hour were; splitters, 19 to 22 cents; blockmakers, 18 to 20 cents; laborers, 12 to 15 cents. The total output of roofing slate from all the sections for 1884 was as follows: Bangor and Pen Argyle section, 194,545 squares; Slatington, 104,000 squares; Vermont, 85,000 squarse; Maine, 41,000 squares; Chapman's 29,499 squares; Peach Bottom, sqs. 10,000; Virginia, 9,000 squares. Total, 474,004 squares. This, compared with the output in 1873 shows a reduction of over 42,000 squares, the production that year being the greatest for years. The prices during 1884 on board the cars at Slatington varied from $3.50 to $4.00 per square, depending on the size of the slate. One of the leading operators has been offered $3.25 per square for his total product, but it was declined, for the reason that better prices are confidently expected. There is very little slate imported, the importations last year numbering 437 packages, valued at $1,886. The exports numbered 2,776,239 pieces, valued at $90,262. Our chief customer for slate is Australia, which took the bulk of the exportations.

Numeration Among Savages.

Prince Roland Bonaparte in *Les habitants de Surinam* speaks of the peculiarity of numeration among the Indians of Dutch Guiana. For these tribes there is in reality only four names for numbers, designated by the names of the first four fingers on the hand. For "five," they say "one hand;" for "six," "one hand and the second finger;" for "ten," they say two hands;" for "twenty," the term is "a man;" and for "forty-seven," "two men, one hand, and the second finger,"

BLOOMINGTON, Ill. While boring a well for water at a depth of 60 feet a strong vien of natural gas was struck



A Floating Coffer Dam.*

BY EDWIN F. SMITH.

To facilitate the removal of rock obstructions, which required blasting, from certain river channels of the Schuylkill navigation in 1880, a floating coffer-dam was used, a description of which may be of interest to members of the Engineers' Club.

The accompanying drawing shows the coffer-dam in plan and section. The outside dimensions are 32 by 48 feet, and the inside 20 by 36 feet. These dimensions were fixed as a matter of convenience only, the dam being framed in two halves, cut longitudinally, as represented by the cross-section *A*, for the purpose of passing the locks of the navigation, the two cribs, when coupled end to end, making a float 96 feet long by 16 feet wide.

The peculiar features of this coffer dam consisted:

First.—In its being framed in two halves, as above described, thus affording facility for moving it long distances through the locks of an artificial navigation, and also for its use in laying the foundations for a bridge pier, or other similar structure, after which it could readily be removed, without injury to the dam itself, by uncoupling and removing each section.

Second.—The application of water-tight chambers or boxes to the crib, by means of which it was floated from one point to another, and greater facility afforded in setting it over obstructions. These boxes were also utilized to contain the stone with which the crib was settled to its proper position over or around rock. When this was done the chambers *D D D* were filled with stone and the dam was ready for sheet piling.

The thickness of the sheet piling was from three to four inches, according to the height of the bottom stringer from the rock, and all sheet piling was carefully fitted to the rock by the diver. Puddling of good, heavy, gravelly material was next dumped around the sheet piling and allowed to settle generally over night before pumping out the dam.

This coffer dam was operated, usually in 7½ feet of water, but upon one occasion a depth of as much as 11 feet was encountered at one end along one-half of one side, without causing any trouble. The permanent crib was framed 8 feet high.

The taking up of the dam was the reverse of the operation of setting it, the water-tight compartments being first pumped out and cleared of stone. The cost of the coffer dam complete was $1128.32, in 1879. It was used during the years 1880, 1881 and 1882, being shifted from one position to another a great many times, and is still in good order and fit an obstruction. The *modus operandi* was as follows: When the crib was being moved from one point to another, the water-tight compartments being pumped out, giving greater buoyancy to the crib. Having located it over an obstruction, the spuds *B B* were dropped and the plugs *C*, of which there was one to each chamber, removed, allowing them to fill with water. At the same time stone was piled on temporary platforms on the sides and ends of the crib until it was settled to the bottom. A submarine diver was then sent down to put in blocking of stone or wood at distances of about eight feet apart at all places where the inside and outside stringers stood off the for service. The same sheet piling was used over and over again, with the addition of 5 to 10 per cent. of new material for each shift. It was 3 and 4-inch white pine, jointed. The men became so well accustomed to shifting the dam, that *seven* men could make the shift, including pumping out ready for work, in 4 to 6 days, the average cost of four shifts being $86.19 for labor only. For pumping, a 6-inch Andrews centrifugal pump was used, and at some locations the sheet piling was so tight that very little pumping was done. Ordinarily the pump was run three minutes out of every ten. For the removal of rock, a steam drill was used, and all blasting was done with a battery.

As the dam was framed with cribs of only 6 feet thickness, it required bracing inside while it was being pumped out and during the prosecution of the work.

For moderate depths, this dam, it is believed would answer every purpose where work is required upon a number of points in succession, and at a much less cost than the ordinary coffer dam—two walls of posts, stringers and sheet piling with an interior filling of puddling, which is often very difficult and expensive to remove after the completion of any work.

*Read November 18th, 1884, before the Engineer's Club of Philadelphia, and taken from the Proceedings this Club. Vol. IV: No. 4.

THICKNESS OF BOILER PLATES.—A bill has been passed by both Houses, and sent to the President for approval, which changes the existing law in regard to regulating steam boilers used on vessels. Section 4,434 of the Revised Statutes provides that no boiler used on steam vessels to which heat is applied to the outside of the shell shall be constructed of iron or steel plates of more than $\frac{1}{4}$ inch in thickness. This statute is amended by a proviso added thereto permitting iron or steel plates not exceeding $\frac{5}{16}$ inch to be used in certain cases. As amended, the statute will read: "*Section* 4,434. No boiler to which the heat is applied to the outside of the shell thereof shall be constructed of iron or steel plates of more than $\frac{5}{16}$ inch in thickness, the ends or heads of the boilers only excepted, and every such boiler employed on steam vessels navigating rivers flowing into the Gulf of Mexico or their tributaries, shall have not less than 3 inches space between and around its internal flues. *Provided*, That boilers to which the heat is applied to the outside of the shell thereof may, in the discretion of the Secretary of the Treasury, be authorized and used on steam vessels navigating the Atlantic or Pacific oceans or salt-water bays or sounds, or the Great Lakes, or any of them, or waters flowing to and from the same, or any of them, when constructed of iron or steel plates not exceeding $\frac{5}{16}$ inch in thickness."

A NEW kind of "white bronze" is made of 40 parts of copper and 60 parts of ferro-manganese, with a sufficient quantity of some suitable flux. The mixture when melted is cast in blocks, and it is then perfectly malleable. To obtain a white metal that can be rolled out into sheets the alloy is melted again and 20 or 25 per cent. of zinc or white metal added. This "white bronze" is said to be more tenacious than the best steel manufactured for armor plates.

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The New Croton Aqueduct.

Work on the new Aqueduct has commenced in earnest. All of the shafts are being sunk, and at shafts Zero and 11 A., on the work of Brown, Howard & Co., drifting in the tunnel has been started. Brown, Howard & Co., have equipped their portion of the work with an excellent and permanent plant, costing in the neighboroood of $350,000. Their hoisting engines are from the Dixon Manufacturing Co. and the Lidgerwood Co., and their compressors and drilling plant from the Ingersoll Rock Drill Co. So far they have been little troubled with water in shaft sinking.

Suakim to Berber.

In our last issue we incorrectly stated the pressure per square inch in the Worthington pumps to be used in forcing water from Suakim to Berber. This pressure was given as 200 pounds, it should be from 1,000 to 1,500 pounds per square inch.

According to the profile of Col. Prout, the greatest elevation on the route, above sea level, is 3,063 feet and the Nile near Berber is 1,244 feet above the Red Sea. In estimating the work to be performed in forcing water the distance proposed and through lines of 4-inch pipe, with pumping stations from 25 to 30 miles apart, it is well to compare the scheme with the duty being daily performed on our own oil pipe lines in Pennsylvania.

The Worthington Co., doubtless owe their present contract, in the face of bitter competition from English builders, to what they have already done on the main line of the Standard Oil Company. The pumping engines there used for years past are in most cases from 450 to 500 horse power, and are forcing oil under pressures of from 900 to 1,500 pounds to the square inch. The capacity of the larger pumps is from 26,000 to 28,000 barrels of oil per day of 24 hours. The pumping stations are from 28 to 30 miles apart, though, in testing the engines, the oil has been forced a distance of 110 miles by loops around the stations. The elevations surmounted extend to 3,000 feet above the sea-level.

It will be seen then, that as far as the makers of the pumps are concerned, they are attempting no untried task, but are simply re-producing in Egypt a plant similar in nearly all respects to those long tested in Pennsylvania.

The *Manchester Guardian*, of England, in speaking of the proposed Suakim—Berber railway, says that "the most valuable of the published accounts of the communications between Suakim and Berber is the report of a survey made in 1875 by Major Prout, an American officer then in the Khedive's service." This is the survey for the first time published and illustrated, outside of Egypt, in our last issue.

The Canals of Corinth and Suez.

According to *Le Canal de Corinthe* of Feb. 14, 1885, about 1300 men are employed on that work, and in Dec. 1884 and Jan. 1885, the amount of material removed was about 92,000 and 103,500 cubic yards respectively. The same journal announces the recent appointment of M. Dominique Bazaine, late Chief Engineer of the Bourbonnais system of railways, as chief of the International Society of the Corinth Canal.

Le Canal de Suez, of Feb. 12, 1885, states that between Feb. 1, and Feb. 10, 1885, 1100 ships passed through the Suez Canal, and that the traffic receipts were, for the ten days named, augmented by the sum of 1,810,000 fr. In the report of the meeting of the *Commission Consultation Internationale*, of Feb. 11, the following action was taken in regard to the enlargement of the Suez Canal: The sub-commission having unanimously favored the provisional conclusions of the commission, the latter has decided that "an enlargement, pure and simple, of the maritime canal from the Mediterranean to the Red Sea is preferable to all other systems."

The actual depth of the Canal being 8 metres the commission believe that this should be increased to 8½ metres, with a further deepening of half a metre reserved as the last phase of the execution of the work for the improvement of the Canal. The following figures give the proposed final width at the bend of the Canal:

1st. Between Port-Said and the Amer lakes: 65 metres in the straight portions; 75 metres in curves with a radius of more than 2,500 m; 80 metres in curves with a radius of less than 2,500 m;

2nd. Between the Amer lakes and Suez: 75 metres in the straight portions; 80 metres in the curved portions.

The Panama Canal.

The *Bulletin du Canal Interoceanique*, for Feb. 15th contains the following data relating to the various canal contracts, and an indication of the nationality of the contractors engaged on the construction of the Panama Canal:

Nationality	*Contractor*	*Amount of Contract* Fr.	
England	Jessen	8,000,000	8,000,000
United States	American Contracting & Dredging Co.	45,000,000	54,000,000
	Franco-American Trading Co.	9,000,000	
U. S. of Columbia	Sosa	1,300,000	2,300,000
	Parades	1,000,000	
France	Muraccioli	16,000,000	63,400,000
	Jacquemin	18,000,000	
	Perceped	5,000,000	
	Tnision	7,500,000	
	Carcenac	6,000,000	
	Brochard	8,000,000	
	Bevraggi	500,000	
	Broquin	400,000	
	Chapelle	1,000,000	
	Musnier	1,000,000	
Holland	Cutbill, de Lungo, Watson & Van Hattum	90,000,000	90,000,000
Italy	Bona	4,000,000	5,500,000
	Gandolfi	500,000	
	Lorenzo	1,000,000	
Sweden	Wiesler	650,00	650,000
Switzerland	Sonderegger	12,600,000	12,600,000
		Fr. —	236,450,000

Wearing out a Hammer-Handle by Friction.

We often hear of the constant drip of water wearing away the solid stone, but there are other agencies that work as slowly and effectually.

Mr. Perrey, the director of the steel works of Treblaine (Loire; France), gives the following detail of the wear on a hammer-handle constantly used: A workman in cutting files, about 15 inches long called "bastard," uses a hammer weighing $7\frac{7}{10}$ lbs., and wears out a handle of holly wood in about one year, after having struck about 11,250,000 blows with the hammer. In cutting triangular files, about 5 inches long, and in metal somewhat softer than the above, the hammer used weighs $2\frac{7}{10}$ lbs. and the holly handle lasts about two years, and has been used in striking 25,440,000 blows. The first named hammer has a handle, the section of which is $1\frac{15}{100}$ inches×1 inch, the second handle is 1 inch×$\frac{3}{4}$ inch, both are oval in section.

PERSONAL.

MARTIN SMITH, aged eighty-six years, died at Dayton, Ohio, on March 5. MR. SMITH laid the first track on the Pennsylvania road between Lancaster and Mt. Joy. The rails were nailed to wooden sills after the manner of our street railways.

EDWARD KIDDER, Esq., the Secretary and Treasurer of the Clarendon Water Works Co., of Wilmington, N. C., died at his home in that city, February 25, aged seventy-nine.

MR. KIDDER was a native of New Ipswich, N. H., but settled in Wilmington when about 21 years of age, and had always been identified with the business interests of that city. To him more than to any other one man was the city indebted for the establishment of water-works, with which undertaking he was prominently connected from its first inception.

HERMAN J. LOMBAERT, the well known Pennsylvania Railroad engineer, died March 10 of a complication of diseases that for several years had been gradually undermining his strength. He was born at Easton, Pa., on October 30, 1816, and came to Philadelphia to be educated. His first engineering work was in the construction of the Philadelphia and Trenton Railroad under Samuel H. Kneass. His ability was soon recognized, and, as soon as the line had been built, he was employed as assistant engineer to design and construct the Philadelphia, Wilmington and Baltimore Railroad.

From that time on Mr. LOMBAERT led a busy life. He worked almost day and night. It was to overstudy and to too close application to his engineering schemes that he owed the ill-health that subsequently caused his death. In 1844 he went to South America, at the instance of the Government of Columbia, to survey a route for a canal from the City of Carthagena to the River Magdalena. He came back to this country in the following year and was engaged on a number of important works in New England and Pennsylvania. His special ability, however, lay in the construction of railroads, and, appreciating this, J. Edgar Thompson asked him to enter the service of the Pennsylvania Railroad. In 1850 he became one of the engineering staff of that corporation.

At first he was located at Harrisburg as assistant to Engineer Hermann Haupt. When the road was completed as far as Altoona, MR. LOMBAERT went to that place and became general superintendent of the road. In this capacity he administered the transportation department of the road with great success. He held this position until 1857, when he came to Philadelphia and was promoted comptroller and auditor. In 1869 he was elected second vice-president of the road. In 1872 his health gave way under the continued strain of work,

and he gave up his connection with the company. Since then he was a confirmed invalid.

Will The Washington Monument Stand?

John C. Goodridge, Jr., the well known inventor of the method of repairing structures with béton or concrete, has written an article upon the stability of the now finished Washington Monument, in Washington, D. C., and the heading above forms the rather startling text of his paper.

From the advance sheets of this pamphlet we make the following abstracts: Mr. Goodridge first refers to the conditions of the monument and its foundations as they existed in 1878, when work upon it was recommenced, and from "The Report of the Joint Commission," quotes the report made in Nov., 1877, by Lieut. W. L. Marshall, U. S. Eng'rs, as follows:

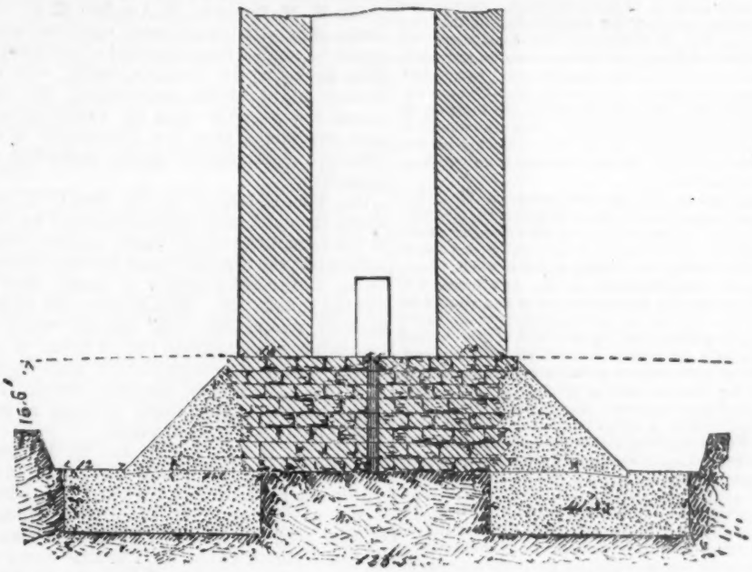
If the shaft be completed, the stability of the foundation, under the most favorable circumstances, *i. e.*, when the air is at rest, will be one and one-tenth. If the only pressure were a vertical one, uniformly distributed over the base of the foundation, no reason can be seen for fearing its stability: but if we consider the foundation courses are of rough blocks, laid directly upon ordinary earth, of indifferent bond and imperfect surfaces, with a considerable proportion of mortar, and consequently not of considerable transverse strength, and subject to considerable alterations of pressure, there does not seem to be a large margin of safety. In fact, the pressure at the base of the foundation on earth will equal or exceed what is usually allowed by engineers as a safe load for brick. The spread of the foundation is such that in violent storms there will be excess of pressure on one side of the foundation over that on the other of nearly five tons per superficial foot. All the variations of pressure will be greater than the entire pressure upon any earth foundation I can find recorded. The facing has been so executed that the greatly increased pressure which may be brought upon it will in all probability deface the shaft and effect its durability.

Generals Barnard, Tower and Wright, under date of Aug. 7, 1874, also state, that "as the result of our investigations five tons is an excessive pressure for soil composed of clay and sand," and they do not recommend any additional weight upon the site of the Washington Monument.

Under the act of Congress of Aug. 2, 1876, appropriating $200,000 for the completion of the monument, the second section of that act stipulated that this sum was conditional upon a thorough examination of the foundation to "ascertain whether it is sufficient to sustain the weight of the contemplated structure, and if the same shall be found insufficient then the further continuance of the work shall not be authorized." A very complete report was made by the Board of Engineers, composed of Col. Kurtz and Generals Duane and Gillmore.

In describing the shaft they say: "It is composed of rubble masonry, with an ashlar facing of white or nearly white marble, very closely joined on the exterior. As a consequence of this faulty method of construction which necessarily implies the use of a much greater proportion of mortar in the hearting and backing of the wall than in the thin joints in close proximity to the face, there has been unequal shrinkage and settlement in the masonry of the shaft itself, by which excessive weight has been brought upon the exterior edges of the ashlar blocks near the base of the structure. The shaft rests upon a foundation of rubble masonry of inferior quality, roughly laid up in moderately hydraulic mortar, in courses of about three feet rise; the stones of each course being of random dimensions, with a preponderance of rather large sizes. They are roughly split to approximately rectangular faces, as far as could be judged by the portion exposed to view, the deficiencies being supplied during the process of construction by a liberal use of mortar with thinner stones or fragments embedded therein. The Board submits its opinion as follows:—That the stratum of sand and clay upon which the monument rests is already loaded to the limits of prudence, if not, indeed, to the limit of safety, and that it does not offer sufficient resistance to compression to justify the completion of the shaft in accordance with the modified design, or any other design that will load the underlying soil beyond ten thousand pounds per square foot. That additional weight imposed at the top of the structure would, in all probability, cause additional and possibly, extensive spawling and splitting in the ashlar facing near the base."

CROSS-SECTION OF BASE OF WASHINGTON MONUMENT.



About this time Mr. Goodridge, an expert in the use of béton and concrete under similar conditions, submitted plans for the extension and strengthening of the foundation. The substance of this plan, as given in a letter of Oct. 29, 1877, was as follows: To enclose the old foundation in a circumscribing wall of béton of high tensile strength, the béton wall going below the original foundation; to increase the strength of this wall, if deemed necessary, by the insertion of iron rods or chains, and to carry tunnels from the walls to and under the foundation and fill with béton. The shape of the new foundation was likened to a cart wheel laid flat, the monument resting on the hub; the center being higher than the rim the outer earth would have to be forced out and the ring forced apart before the center could settle. No action was taken upon this proposition.

Colonel Casey was then appointed Engineer of Construction of the Washington Monument, and the method of repairs adopted has been frequently and fully described. (See ENGINEERING NEWS, Feb. 7, 1880). From the report of Col. Casey the following is quoted:

"The several methods that have been suggested for securing the foundation of the Monument so as to permit its further construction, can be divided into two general classes, the one proposing to hoop in the earth beneath the foundation, so as to prevent its lateral displacement under the additional load to be brought upon the bed of the foundation; the other to underpin and extend the surface of the base of the foundation, so as to distribute the load over a greater area and within the limits of resistance of the soil to be pressed. The latter method is the one adopted in this project.

"To back the old foundation in with the new, and distribute the pressure more uniformly over the new mass, three large buttresses on each side of the structure—twelve in all—are carried from the upper surface of the new foundation up and under the outer portion of the shaft." * * *

"The construction of the foundation proposed will require great care, attention, and skill on the part of the workmen. To undermine a structure weighing nearly 32,000 tons, and to replace, to a considerable extent, with masonry the earth upon which it rests, is evidently a delicate operation. It is believed, however, the work can be successfully accomplished by introducing the masonry in thin vertical layers, not over four feet in width, having first tunnelled under the structure with drifts of that width and the required height and length. These layers can be connected to each other by dowel stones set in the faces of the layers as the work progresses, and with panel depressions in the alternate layers, into which the intermediate layers would be moulded. The material of the layers will be strong Portland cement concrete, except, possibly, for a short distance just under the old foundation, where rubble masonry may be forced in and wedged up under the stones of that structure.

In criticising this construction, the author of the pamphlet states that all this was well as far as it went, but it did not go far enough. The shaft is 55 feet square, and rests upon a loose mass of rubble masonry, without tensile strength and stated by the engineers as being unable to bear any transverse strain. We quote Mr. Goodridge as follows.

Under this shaft of 55 feet square is left an opening 45 feet square. The walls of the monument are 15 feet thick, and the new foundation extends but 5 feet under this wall, leaving that portion of the shaft giving the greatest pressure as a dead load to be carried by the clay portion of the upper soil. It is evident that the greatest weight comes just where the new foundation stops. This new foundation or footing course extends outside beyond the line of buttresses, forming a leverage caused by the greater pressure at the center of the monument. These separate sections have no sustaining bond to hold the mass together, and it is within the strong possibilities that this, by making new positions, will cause a new set of strains which the structure is unable to bear.

We have also an enormous load upon our foundation, which we may consider as follows:

Let us first take the weight of the monument, which is given in the report as 81,120 gross tons for monument and foundation. In other reports of Government engineers the ton of 2,000 pounds is taken, and such has been the practice among civil engineers. We see no reason for using the gross ton except that it lessens the apparent weight of the monument by some 9,700 tons (ninety-seven hundred tons). The pressure on the soil below, as given in the reports, should, for the sake of comparison with other structures, be given in the ordinary tons. We find the area of the completed foundation to be 126½ feet square—equal to 16,002 square feet. The weight of the monument 81,120 long tons, which equals 90,854 tons. This divided by the area of foundation—16,000 feet—gives a uniform pressure of 5⅝ tons (11,340 pounds) over the entire area of the base. If from this taking the fact that there is within the sub-foundation a space of 45 feet square, equal to 2,025 feet square, which is, from previous reports, manifestly unable to carry its proportion of the great burden, we have 16,000 less 2,025, which gives us 13,975 square feet of concrete footing, which transmits the weight to the soil below.

Taking this at 14,000 square feet, and the weight to be carried is 181,708,800 pounds, we find we have a weight of 12,979 pounds pressure to the square foot—equal to about six and a half tons. The tunnels which were filled with concrete slabs, are 41 feet long, passing but 5 feet under the main shaft of the monument, the foundation between the concrete and the shaft being of poor rubble masonry, and being 18 feet in all under the old foundation and shaft, extending 23½ feet outside of the old foundation, 10 feet of which is attached to the old foundation by buttresses. The shaft of the monument is 55 feet square on the outside, its walls 15 feet thick, while the open space below is 45 feet square. It is evident that the pressure is greater immediately below the monument than on the outside of the concrete footing course, and in this construction more than in ordinary masonry, because the blocks of concrete are unconnected and placed side by side. There are no superimposed courses with overlapping joints. Now, all the concrete footing course that extends beyond the buttresses has not only less pressure than the other portion, but from that fact makes a point of enormous leverage, the tendency being to force the central por-

tion down and out, tearing apart the lower portion of the old foundation, and crowding the top of it together through the medium of the buttresses. Leaving out the detrimental effect of the concrete footing that goes beyond the line of buttresses, and considering the foundation to end there, we have as the area covered by buttresses 101¾ feet square, equal to 10,302 square feet, disregarding fractions. Deducting from this the unsupported portion of 45 feet square in the interior, we have remaining 8,277 square feet to carry the weight of 21,953 pounds, or nearly eleven tons to the square foot on the bottom of the concrete footing course and on the soil beneath it.

This does not include any wind pressure. We find in the Report of the Engineers as previously quoted that on the old foundation (whose area was 6,400 square feet), in violent storms, the excess of pressure on one side of the foundation over that on the other would be nearly five tons per superficial foot. As the new foundation available to receive such pressure is less than 83,000 square feet assuming the previous figures to be correct, we will have added to our constant load of three tons of wind pressure per square foot, which, with the load, makes about 28,000 pounds, or fourteen tons, per square foot. If the concrete footing blocks had extended to the center of the monument, then the load would have been distributed in a different manner. As the main pressure of the weight of the monument comes near the inside of the footing course, and as such pressure must exceed the pressure on the perimeter of the foundation, we look to find a greater settlement at the inner point. We have enormous leverage transmitted through the buttresses to the old foundation, which from the reports given of it must be unable to withstand such a force; while the strains on the old shaft will be brought to new points by the changes of position, and lead to its dismemberment.

In regard to the concrete foundation, we are told that it is composed of one part cement, two parts sand, three parts pebbles, four parts broken stone. My occupation since 1870 has been the manufacture of beton and concrete, and since 1875 almost entirely in strengthening foundations, etc., and I have never thought it safe to use so weak a material as the one described. The only advantage that I can see in the proportions is that the numerical order is an aid to the memory of the mixers, and perhaps lessens the strain on the mind of the engineer. It is difficult to understand how such a mixture could be thoroughly compacted; and when we find that the upper portion was rammed in in gunny bags, we do not know how all the vacuities could be filled, except by the settling of the structure above it. Taking the load and the wind pressure combined, we have a distributed pressure on one side of the monument of nearly 200 pounds to the square inch; it will be in excess of that in some portions at certain points.

How long such a structure can stand under the pressure as described is simply a matter of supposition. Experience shows, as stated in one of the reports on the Washington Monument by Government Engineers, that even on overloaded soil "protracted time is necessary to produce sensible results."

It has been demonstrated that a monument can be raised to the height of 555 feet on such a soil as underlies the Washington Monument, but that it can be sustained there, is still to be proved.

American Society of Civil Engineers.

RECORD OF MEETINGS.

FEBRUARY 18TH, 1885.—Vice-President G. S. Greene, Jr., in the chair. Discussion on the paper by E. Sweet, M. Am. Soc. C. E., on the Radical Enlargement of the Artificial Waterway between the Lakes and the Hudson River was continued.

Mr. E. S. Chesbrough, Past President Am. Soc C. E., by letter, considered it advisable to make the surveys and estimates recommended by Mr. Sweet.

Mr. Walton W. Evans, M. Am. Soc. C. E., said that when speed was not brought in as an element, no railway can stand in competition with a well constructed water line. Statistics show the influence of the Erie Canal on railway freight charges. The best policy for the State of New York will be to enlarge and improve this waterway. He referred to the fact that Gouverneur Morris was the projector of the Erie Canal. He suggested the possible use of elevators instead of locks, and the use of preserved wood in many places instead of stone.

Mr. T. C. Clarke, M. Am. Soc. C. E., said that the cost of repairs and the interest on the amount to be expended in making the proposed improvement would be very large. The canal would be shut half the year by ice. The railroads are always ready. Hence the fact that the canal carries so small a portion of the freight.

Mr. N. M. Edwards, M. Am. Soc. C. E., estimates that with the proposed waterway wheat could be carried from the head of the lakes to New York City for 5 cents a bushel, with 1 or 2 cents added if tolls are required. He compared the possible rates by various routes, and considered that the advantages of the proposed enlargement should command recognition.

Col. Wm. E. Merrill, M. Am. Soc. C. E., considers the chief merit of the project to be, that it will reduce the cost of wheat to a theoretical minimum; the benefit of such a radical cheapening of the chief article of human food is beyond calculation. He considers the project entirely practicable. The current would be somewhat objectionable, but in favor of the heavy traffic. He suggests fixed dams on the Mohawk rather than movable dams. The great military advantages of such a ship canal should not be overlooked.

Mr. John D. Van Buren, Jr., M. Am. Soc. C. E., compared two routes for a ship canal within the State of New York and two which would be international—those from Chicago to New York, by Buffalo and the Erie Canal, by the Welland Canal (or a similar canal on the State side) and Oswego by the St. Lawrence and proposed Caughnawaga Canal and by the proposed Ottawa and Caughnawaga Canals.

The Oswego route is deficient in water. The Ottawa route is a day shorter in time than the Erie. It is an important question whether the advantages of the international route would outweigh the importance of having the route entirely in the State.

Basing an approximate upon the cost of the present Erie Canal, Mr. Van Buren makes a grand total of $194,000,000 as the probable cost of the proposed Erie Canal route, which, with interest during ten years of construction, would amount to $240,000,000. This is about three times the estimated cost of the Nicaragua Canal, and more than three times the actual cost of the Suez Canal,

The true test for a proposed government or private work is the commercial one. Will it pay? Unless the cost of transportation would be materially reduced below the cheapest present normal rates the enterprise would prove a failure and no benefit. Taking a probable interest charge and an annual expense for repairs and management at the same sum as that expended on the Suez Canal, and a total tonnage of 20,000,000, Mr. Van Buren estimates the charge for the support of the canal at 3 cents per bushel of wheat from Buffalo to New York. Looking at the matter as a private enterprise, the conclusion is reached that a private company would hardly dare undertake the work.

Considered as an undertaking by the general Government, the question is, what interest, under the Constitution, has the Federal Government in such a project? It would be difficult to induce Congress to appropriate funds for an improvement likely to seriously damage the interests of neighboring States.

Considered as a State enterprise, it must be as a free canal. The general benefits would be those attending a great increase of business. The people of the State would have to pay about $16,000,000 per annum.

Mr. D. Farrand Henry, M. Am. Soc. C. E., said that the question was not solely how to reach New York, but how to reach Liverpool. Three routes have been proposed: from Chicago to the Mississippi by the Illinois River; the enlargement of Erie Canal; the deepening of the Welland Canal and the improvement of the St. Lawrence. Comparing these routes, the conclusion is reached that the latter is decidedly the most feasible.

Mr. O. Chanute, M. Am. Soc. C. E., suggested that the question should be considerd whether it may not be considered whether it may not be practicable to apply some form of heat engine different from any heretofore tried, for the propulsion of the boats on the present canal, and thus secure economy and speed and large carrying capacity for the canal as compared with the great interest charges on the waterway proposed by Mr. Sweet.

Mr. C. Herschel, M. Am. Soc. C. E., discussed the regulation of railroad freight rates by the encouragement or the creation of water competition, rather than by a reliance wholly upon the work of railroad commissioners, or upon the successful enforcement of rigid statutes designed to forbid excessive and discriminating freight rates, under pains and penalties.

Mr. Theodore Cooper, M. Am. Soc. C. E., did not consider that freight could be taken economically by the same vessel from Chicago or Duluth to Liverpool. The vessel constructed properly for ocean navigation would not be suitable for the canal or the lake. The vessel constructed to carry freight economically on the lakes is not fit for ocean voyages.

Mr. J. Nelson Tubbs, M. Am. Soc. C. E., by letter, expressed doubt of suitable provision for water supply on the long levels of the proposed canal, as the evaporation and percolation would be very great.

Mr. E. Sweet, M. Am. Soc. C. E., considered the various points that had been brought forward in the discussion. He gave figures to show that the losses by percolation and evaporation could be supplied from Lake Erie by a current of about six-tenths of a mile per hour. This current would increase going eastward till reaching the long level, across which it would not exceed three-tenths of a mile per hour. It would be in the direction of the heavy traffic and a benefit rather than a hindrance to navigation. He stated that the estimates of Mr. Van Buren proceed from erroneous premises as they assume the cost of the present canal at about $49,000,000, which is 50 per cent. more than its actual cost as shown by the State records. These show that the enlargement between 1835 and 1862 cost $31,834,000. The structures of the original canal were discarded in the enlargement, and its route was almost as generally disregarded as the route of the present canal is in the proposed ship canal. The cost of the original canal should not, therefore, be considered in such an estimate. But, even adding this to the cost of enlargement, and all the interest of all the loans for constructing and enlarging the canal, the sum assumed by Mr. Van Buren is not reached. Taking the actual cost and applying the principles he adopts, the estimate becomes $127,000,000. Three per cent. interest charges are more probable than the five per cent. assumed by Mr. Van Buren. The interest charge would thus be $3,810,000 instead of $12,000,000. He also estimates maintenance too high.

The suggestions favoring the adoption of the St. Lawrence route, apart from the questions of State and National interest and patriotism, simply would by that location aid foreign commerce and defeat the chief object of the proposed improvement which is to facilitate the vast domestic traffic between the East and West. Its tonnage is now many times that of the foreign commerce tributary to either route, and the disparity will surely increase with the facilities proposed.

The suggestions of Mr. Chanute would not result in the speed desired. The essential defects of small canals is that the boats must have too large an immersed surface for the tonnage they carry, and thus enormously larger resistance per ton than large vessels.

Replying to Mr. Corthell, Mr. Sweet said that while the railroad is the most important instrument of internal commerce, it has limitations of capacity and economy. The limitations of economical water carriage are quite different. The economy of water transit increases with the size of the vessel, and the

capacity of artificial waterways increase nearly as the cube of their depth of channel.

Mr. Sweet also showed that a speed of five miles per hour could easily be realized by large vessels in the proposed canal from Buffalo to Utica, and of ten miles per hour from Utica to New York. This, with proper allowance for detentions at locks, would give a duration of voyage from Buffalo to New York of 85 hours.

MARCH 4th, 1885.—President F. Graff in the Chair.—The vote on the proposed amendment to the Constitution was canvassed as follows:

For the amendment	181
Against the amendment	28
Blank votes	3
Ballot not endorsed	1
Total votes received	213

This proposed amendment, having received an affirmative vote of two thirds of all ballots cast, was declared duly adopted as an amendment to the Constitution of the Society, it reads as follows:

Add at end of Article XXII:

Any member of the Society, not in arrears for dues, may compound for the payment of all future annual dues, except as hereinafter provided, by the payment of Two Hundred and Fifty Dollars.

Provided, That all Residents Members, or those who may hereafter become such, shall be and remain liable to the annual payment of the difference between the annual dues of Resident and Non-Resident Members, as the same now is, or may be established from time to time; but any member may at any time compound for the future payment of all annual dues of every nature and kind, by the payment of Seventy-Five Dollars in addition to the Two Hundred and Fifty Dollars hereinbefore provided for.

Provided, however, that each person duly elected a member shall pay the entrance fee and also the annual dues for the current year of his election.

Provided, also that any member desiring to compound for future annual dues shall have paid the annual dues for the current year before the compounding sum may be available.

Members compounding shall sign an agreement that they will be governed by the Constitution and By-Laws of the Society as they are now formed, or as they may be hereafter altered, amended or enlarged; and that in case of their ceasing to be members from any cause whatever, the amount therefore paid by them for compounding, and for entrance fees and annual dues, shall be the property of the Society.

All moneys thus paid in commutation of annual dues shall be invested as a permament fund, the interest thereof only being subject to appropriation for current expenses.

The death of Mr. F. W. Merz, F. Am. Soc. C. E., and of Mr. Arba Read Haddock, Assoc. Am. Soc. C. E., were announced.

At the Annual Meeting, the following resolution was adopted:

Resolved, That the President be authorized to appoint a committee, consisting of five members, to confer with committees appointed by kindred societies, for the purpose of devising and considering a plan for creating a library for the general use of the organizations represented by the committees in conference; said plan to be reported to the Society for such action as may be desirable.

Under the provisions of this resolution, the President announced the appointment of the following committee: Messrs. William P. Shinn, Henry R. Towne, Thomas C. Clarke, M. N. Forney and George S. Morison.

The following letter, received since the last business meeting of the Society, was presented:

THE AMERICAN EXHIBITION IN LONDON, 1886,
LONDON, Jan. 24th, 1885.

JOHN BOGART, Esq.,
Sec'y Am. Soc. C. E.:

DEAR SIR.—Since my last letters to you, I have informally heard from and seen the representatives of many societies, corporations, etc., who offer to cooperate most cordially with the Executive Council of this Exhibition, in making agreeable the visit of those members of our Society who may accept the invitation contained in my last letter, viz.: to hold our annual summer convention next year in London. At this distant period nothing would be gained by making a definite programme, as time would necessarily make many changes in it, but enough has been sketched out to warrant me in saying, that those who may accept the invitation will not regret it.

Yours most truly,

EDWARD BATES DORSEY, *M. Am. Soc. C. E.*,
Consulting Engineer to the Exhibition.

The presentation to the Society by Simon Stevens, Esq., of the Parliamentary Reports on the Caledonian Canal, from 1803 to 1871; the maps, profiles and drawings of the same canal; the working specifications of the Amsterdam Canal, 1865 to 1870, and the description of the North Sea Canal of Holland (subject to withdrawal by Mr. Stevens), was announced.

A paper on the Cantilever Bridge at Niagara Falls, by C. C. Schneider, M. Am. Soc. C. E., was read by the author. The preliminary study and estimate for this double track railroad bridge was made at the request of the Central Bridge Company of Buffalo, by Mr. Schneider, in October, 1882, and he at that time concluded that the river span should be so designed as to allow it to be erected without false works, and that a hinged arch on the cantilever principle would be the proper form of construction, he having in the spring of 1882 designed the Fraser River Bridge for the Canadian Pacific Railway where similar conditions existed precluding the use of false works. After securing a profile of the site, the design and estimates were perfected and a tender for the construction of the entire work submitted by the Central Bridge Company to the Niagara River Bridge Company, and after approval by their consulting engineer, Mr. Charles H. Fisher, M. Am. Soc. C. E., the contract was awarded on April 11th, 1883, to the Central Bridge Company, on condition that the structure be completed on December 1st of the same year. The contracts for portions of the work were sublet: excavations and masonry to Dawson, Simmes & Mitchell; false works to C. H. Turner; Beton foundations to John C. Goodridge, Jr.; steel and iron compression members for towers to Kellogg and Maurice.

Mr. Schneider was appointed, by the Niagara River Bridge Company, Chief Engineer on April 26th. The work, both at the bridge site and the shops, was vigorously pushed, and the bridge was completed and opened for traffic on December 20th, 1883, about eight months from the commencement of the work.

The bridge is over the Niagara River, about two miles below the Falls and 300 feet above the Railroad Suspension Bridge. The Bridge spans a chasm of 850 feet in width and 210 feet in depth to the surface of the water. The river is 425 feet wide at the bridge site; the water has a velocity of 16½ miles per hour at the centre of the river. The depth is supposed to be from 50 to 80 feet. The banks on both sides slope at the cliff, above which they are horizontal. The sloping banks consist of a mass of large boulders and broken stone from the hard limestone layer which forms the upper stratum, mixed with earth and *debris*. This hard limestone, which has been undermined by the water acting upon it and cutting away the argillaceous rocks, has fallen in hard masses and formed a natural rip-rap, preventing further erosion. The pits for the towers at the water's edge were in this loose hard stone. No solid rock was found. It was determined to prepare the bed for the masonry upon the very large boulders at the bottom of the pits by filling to a depth of about 8 feet with Beton Coignet, well rammed into all interstices on bottom and sides. The foundation area for each pair of piers is about 1,000 square feet and the weight about 5,930,000 pounds, or 5,930 pounds per square foot. The stability of this foundation was considered by two Commissions of Engineers, both of which Commissions expressed themselves satisfied as to their stability. The members of these Commissions were Messrs. George S. Morison, Macdonald, John A. Wilson, A. W. Stedman and Theodore Cooper.

The masonry of the piers is limestone laid in cement. They are 38 feet high above the beton. The stones were lowered from the trestle, afterwards used for erection of the towers and shore arms of the cantilevers. The anchorage piers are on the top of the cliffs. They are built on a platform of plate-girders, connected by anchor bars to the shore ends of the cantilevers; thus utilizing the weight of the whole mass of masonry of the piers. Each anchorage pier weighs about 2,000,000 pounds.

The towers are 132½ from top of masonry to center of lower chord of cantilevers. Each tower consists of four main posts, with horizontal struts and diagonal tie-rods. Each post is formed of steel plates and angles. The horizontal struts divide the towers into five sections of nearly equal height. The posts have a batter of 1 in 8 at right angles, and of 1 in 48 parallel to the axis of the bridge. The distance between centers of posts at their base is 60 feet 7½ inches at right angles, and 30 feet 5½ inches parallel to the bridge. They rest on cast-iron shoes at the bottom. The tops consist of steel castings, which support the cantilever on 7½ inch steel pins.

The structure carries a double track. It consists of two cantilevers resting on the towers, the shore ends being anchored to the anchorage piers and the river ends connected by an intermediate span. The distance between centers of anchorage piers is 910 feet 2½ inches, length of each cantilever 395 feet 2 5/16 inches; length of intermediate span 119 feet 9½ inches. The moving load assumed in proportioning the structure was, a train on each track headed by two 66-ton locomotives, having 72,000 pounds on three pairs of drivers, spaced 6 feet between centers, followed by a train load of 2,000 pounds per lineal foot. The floor system is proportioned for 78-ton consolidation engines. The lateral system is proportioned to resist a wind-pressure of 30 pounds per square foot on a train surface of 10 feet height, and upon the exposed surface of truss and floor system; the pressure on the train surface being considered a moving load. Strain sheets accompany the paper.

The tower posts, lower chords, center and end posts of cantilevers, pins, top-castings for towers, are of steel. All the other parts are of wrought-iron, except the shoes for tower posts, filling rings, washers and hand-rail posts, which are of cast iron.

Each cantilever consists of a shore arm 195 feet 2 5/8 inches long, one panel 25 feet over the tower and a river arm of 175 feet length. The cantilever trusses are divided by vertical posts into panels of 25 feet, with the exception of the end panel of the shore arm, which is 20 feet 2 5/8 inches; they have a double system of diagonals and are spaced 28 feet between centers; they are 56 feet deep over the towers, 26 feet over the last vertical post at the river end, and 21 feet over the last vertical post at the shore end.

The upper chords of the shore arm receive alternate tensile and compressive strains, loads which are applied between the anchorage and the tower produce compression, and those applied to the river arm or intermediate span produce tension. These chords are of eye-bars, with a compression member of plates and angles, double-latticed, packed between the bars.

The upper chord in tower panel and the upper chord of river arm are composed entirely of eye-bars. The lower chords and inclined end posts of the cantilevers are steel compression members of plates and angles. The vertical posts over the tower supports are of steel, two plates and four angles. The intermediate vertical posts are of two channels double laced.

All the principle connections are made by steel pins 5½ inches, 6½ inches and 7½ inches diameter.

The cantilevers are connected to the anchorage piers by rockers permitting horizontal movement.

The intermediate span has five panels of 24 feet.

The iron used was manufactured by Atkins Bros., of Pottstown, and Graff, Bennett & Co.,

of Pittsburgh. The steel was made by the Spang Iron and Steel Company, of Pittsburgh. The steel pins and castings were made by the Cambria Iron Company. All the materials were manufactured into finished members at the shops of the Central Bridge Works, at Buffalo, except the compression members for the towers, which were made at the shops of Kellogg & Maurice, at Athens, Pa.

The heads of the eye-bars were formed by die forging.

The towers were erected by means of derricks on the false works, the material being lowered from the cliffs to the floor of the false works and thence to the towers; the tower on the American side was begun August 29th and finished September 8th; that on the British side was begun September 10th and finished September 18th. The shore arms of the cantilevers were then erected on the false works, a track laid on them and the travelers for the construction of the river arms put in position. These were substantial wooden frameworks on iron wheels. The travelers were fastened by clamps to the floor-beams of the completed portion. Each traveler had two derricks connected with a hoisting engine, by means of which the materials were lifted from cars and lowered to their place in the structure. A hanging platform was suspended from the traveler.

The American shore arm was begun September 25th, completed October 15th. The Canadian shore arm was begun October 8th, completed October 22d. The American river arm was begun October 28th; the Canadian river arm was begun November 4th. The last connection was made November 22d. The first track was completed December 6th, on which day a locomotive crossed the bridge. The whole structure was completed December 19th.

The bridge was formally opened and tested in the presence of a large number of engineers on December 20th. The tests were conducted by a committee, Messrs. George S. Morison, Theodore Cooper, Charles Macdonald and Thomas Rideout. The inclemency of the weather at that date made another series of tests desirable, which were conducted by the same engineers, whose report accompanies the paper. The specifications for the bridge and the report of tests on eye-bars also accompany the paper.

JOHN BOGART,
Secretary, Am. Soc. C. E.

The Engineeers Club of St. Louis.

The Club was called to order at 8.15 P. M. by President Moore, twenty-two members and three visitors being present.

The order of business was the reading of a paper on "Treatment of Wood for Street Pavements," by Messrs. Caldwell and Miller. It was discussed by Messrs. Constable, Johnson, Robt. Moore, H. C. Moore and Lansden. Mr. Theo. Plate, President American Wood Preserving Company being present, was called on to give his views. He expressed it as his opinion that the idea that gum wood was a cheap wood, was a mistake, because when all heart wood was required it necessitated more work and consequently greater expense in securing it than has heretofore been anticipated.

Mr. Lansden exhibited a section of water-pipe from Falls River, Mass., which had lain about eighteen months in a bed of cinders, where it was submerged in tide water twice in twenty-four hours. It had disintegrated two-thirds of the way through, leaving a substance as soft as graphite, the pitch coating of the pipe still being plainly visible both inside and out.

THOS. D. MILLER, *Sec'y.*
St. Louis March 4, 1885.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page* 156.)

At night a lamp is fixed on the top of the target standard. These lamps are usually about 6 inches square and 8 inch to 10 inches high, the former dimension depending on the local distance of the lens, which lenses, colored to correspond with the target, are set in opposite sides of the lamp. As a rule green at night means the same as white by day, and red answers to its own color. It is not advisable to use white in a signal lamp owing to the liability of mistaking it for some outside light. Originally plain glass was used in switch lamps, but later lenses have been introduced to concentrate the rays. The efficacy of a lens for this purpose depends on its ability, when the flame is placed at the principal focal distance, to concentrate the rays into a parallel beam. This permits the light to be clearly seen at all ranges, and so is proportionally superior to plain glass where the rays of light can pass through in all directions and of which the greater part are entirely lost as they radiate into space.

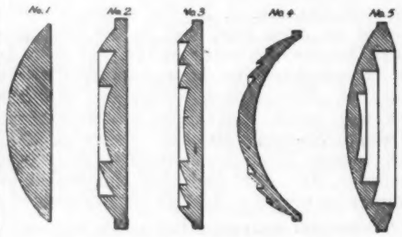


FIG. 68.—CROSS SECTIONS OF LENSES.

Fig. 68, represents various styles of lenses. Lens No. 1 is a plano-convex, commonly called a "bull's-eye." The objection to it is its weight, causing extra expense in prime cost and a heavy strain on the lamp case. Nos. 2 & 3 show two patterns of plano-convex corrugated lenses known as "Fresnel" lenses, after the name of the inventor, differing only in the number of rings. This style of lens is very weak and liable to break. No. 4 is a concave-convex lens, commmonly called the "Semaphore" lens. Unfortunately for its effectiveness, however, the curvature of the faces is such as to scatter the rays of light rather than to concentrate them into a parallel beam. The object of the corrugation is merely to diminish weight and does not effect the principle of the lens, since the Fresnel is really but an ordinary plano-convex (No. 1) "telescoped." The objection to all these external corrugations is the readiness with which they catch snow and ice in winter, and dirt at all times.

The Corning Glass Works have recently perfected a lens called the "Smooth-face Semaphore," a double convex lens shown as No. 5, which is strong, light, and with the corrugations on the inside. Great care was used in its designing so as to render effective all the rays which pass through it. Photometric experiments conducted by me place their relative effective values as follows:

Smooth-face Semaphore	100.00
Three Ring	70.71
Bull's Eye	67.60
Two Ring	48.73
Semaphore	38.03

For single track work a lamp must be provided with four lenses, but on double track only three are necessary, two red and one green, which latter arrangement gives not only economy in lamp construction but greater simplicity and consequent security. For an engineman sees only those safety signals which are on his track and it is impossible for him to be drawn into danger through being misled by a safety signal on the other track. At times of wreck or other cause, when but one track is used, it is not necessary to provide two green signals. While there is only negative evidence for safety there is positive evidence for danger which is really what is demanded; for if the switch is set *wrong* it will show red *both* ways since there are two lenses of that color in each lamp.

Fig. 69 gives a sectional view of a good design for a switch lamp. The socket, bottom and lamp cup holder are all made in one casting, to which the sides of the case are rivetted. The best material for the sides is galvanized iron. The weak point in a switch lamp is the connection between the case proper and the bottom, the design given here, in which no solder is used, is simple, strong, durable and cheap. The oil cup, which should be big enough to hold a fifteen hours supply, slides into a groove as shown, which arrangement prevents its being tipped over or jarred out of place. Ventilation is obtained, as indicated by arrows, through holes in the bottom; the force of the wind is thus entirely broken against the bottom of the cup and before it reaches the flame. The top of the standard on which the lamp sets should be made to correspond with the plan of the socket so that the lamp can be set on only one way. The door, not shown in the figure, should not be hinged but made to slide in guides at the side, which guides should be as deep as possible so as to prevent any leaky draught from affecting the flame. In order to get the angle to hold the lenses the galvanized iron of the sides is swedged out in a mould, a circular collar is then soldered at the back of the lens. The other details of the lamp are shown in the figure and a bill of material and cost is attached.

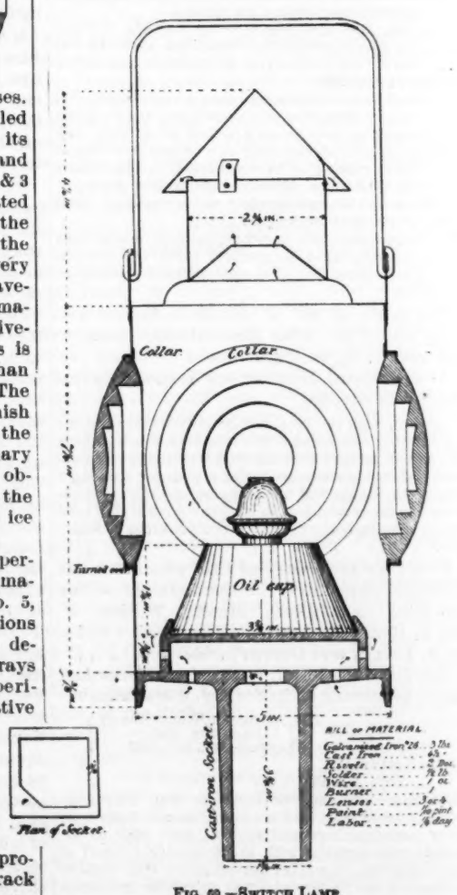


FIG. 69.—SWITCH LAMP.

(TO BE CONTINUED.)

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CORRESPONDENCE.

Pollution of Deep Reservoirs.

PHILADELPHIA, March 5, 1885.

EDITOR ENGINEERING NEWS:—Referring to my discussion at the Engineers' Club of Philadelphia, Feb. 7, 1885. "Of foul water in the lower reaches of deep storage reservoirs," I would add that, in as much as gates at the bottom of deep reservoirs would be expensive to construct and difficult to repair, the same end can be accomplished by means of syphons, the shorter end of which could be extended to the bottom of the reservoir and the longer end extended down stream below the dam to a sufficient distance to get the required fall.

A full description of such a syphon may be found in "Notices on the Models, Charts and Drawings relating to the works of the 'Ponts et Chaussees' and the Mines," collected by order of the Ministry of Public Works, exhibited in the French collection at the Universal Exposition at Philadelphia, 1876, pp. 341-347, under title "Dam & Syphon-weir of the Reservoir at Mittersheim." Such an arrangement in addition to the waste weir can be applied to any reservoir already built, and the foul water taken from the bottom; being automatic, the required level of the reservoir can be maintained and the surplus water taken from the bottom.

Respectfully yours,
CHAS. G. DARRACH,
M. Am. Soc. C. E.

NOTE.—For an abstract of the article on the Mittersheim Reservoir see same page of this issue.—ED. ENG. NEWS.

Grade for Side Tracks.

WASHINGTON, D. C., March 5, 1885.

EDITOR ENGINEERING NEWS:—In reply to inquiry of H. T. McDaniel, Assistant Engineer, Atlanta, Ga., I would offer the following:

Colburn's experiments for the Erie Railway showed that the resistance of trains, on a straight track, in good condition, at slow speed and with good rolling stock, might be as low as 4½ pounds per ton.

The accelerating force due to gravity in pounds per ton is given by the formula:

$\frac{V}{5280} \times 2{,}000$: in which V = any given grade in feet per mile.

Equating this with the resistance in pounds per ton = 4½.

$\frac{V}{5280} \times 2000 = 4\frac{1}{2}$ $V = 11.88$ feet, which is the grade on which a train, in first-class order, ought to just start, but would continue in motion if once started.

Probably little or no trouble would be occasioned by a grade of 16 feet per mile, which would correspond very nearly to a resistance of 6 pounds per ton.

Respectfully,
FRANK P. DAVIS

Creeping of Rails.

BRUNSWICK, GA., Feb. 28, 1885.

EDITOR ENGINEERING NEWS:—In the January 31st number of the ENGINEERING NEWS, appears a communication from Mr. H. W. Reed, Master of Roadway of the Savannah, Florida & Western Railway, in relation to the "Creeping of Rails," in which he explains an expedient he adopted on his road to prevent this creeping on his trestles, which is to bolt "angle plates on each side of every rail *at the center*" and to spike in the slots in the angle plates, allowing the proper space at the joints for expansion. Instead of weakening his rail by boring holes in its web for his angle-plate bolts, would he not arrive at the same result by cutting slots in the foot of his rail *at the center* and spiking in those, or would it not do as well to spike in the slots at *one end* of his rail, allowing the other end to move by contraction and expansion? On the New York Elevated Railroad, one end of each girder is bolted fast to a column, and the other end left free to move. In all large bridges one end is "fixed" and the other permitted to move on rollers. Our experience is, that spiking in the slots at one end of the rail—if on a grade the highest end—works satisfactorily. I doubt, however, if this method alone would prove at all satisfactory in the case of the St. Louis Bridge, where the existing state of affairs is not at all that found on ordinary track.

Very truly,
COLIN R. WISE.

THE work planned for the coming season, by the Cleveland, O., Water Board, includes the completion of the new reservoirs, the new pumping station on Woodland Hills Avenue, and the repairs to the Lake crib. Besides a number of miles of new large and small water mains are to be laid, aggregating about 20 miles. About $23,000 has been spent on the pumping station, when completed it will cost nearly $100,000 more; it will have a stand-pipe tower 230 feet high. The Fairmount St. reservoir will cost about $207,000, and the high service reservoir $125 000. The crib is to be entirely rebuilt in its upper part, wood being substituted for the stone masonry.

The Fouling of Water in Deep Storage Reservoirs.

As the above subject is one of interest to every engineer who has to deal with deep storage reservoirs, we print in full the discussion of Mr. Chas. G. Darrach on the paper read before the Engineers' Club of Philadelphia, on Feb. 7th by Mr. A. Harvey Tyson, on "The Source of Pollution in Storage Reservoirs." The extracts from the letters of Mr. Robt. K. Martin give valuable experience gained in the Baltimore lakes and reservoirs.

MR. PRESIDENT: The subject of the paper before us is of especial interest. Data collected during the past 7 years disprove the old theory that as an approximation we may estimate a daily average yield of 1,000,000 U. S. gallons (133,570 cubic feet) per day, per annum, per square mile of catchment area or the utilization of 23 inches of rainfall. In fact but one-half this amount should be estimated,* we are therefore forced to increase the storage capacity to tide over dry years, calculating the average yield of 24 or 36 months instead of 12 months, in so doing the depth of the collecting storage reservoir is increased, and it is to this point your attention is directed.

In 1875 I noticed that the water drawn from a depth of 50 feet in Tumbling Run dam, was very offensive in odor, but after contact with the air the water became odorless and potable, similar to the water on the surface of the dam.**

In the winter and spring of 1881 the City of Baltimore suffering from bad water, various theories were suggested and if my memory serves me the bad water was drawn from the pipes and from the bottom of the reservoirs.

In 1882 I visited the Baltimore Water-works and became convinced that one, if not *the* cause of trouble was *deep* reservoirs.

After a comparison of notes with Mr. Robert K. Martin, chief engineer, he determined to experiment as follows:

Waste all *surplus* water from the *bottom* of the reservoirs on the Gunpowder supply and allow the Jones Falls surplus to waste over the wiers.

The following data will give a basis of comparison:

DRUID HILL RESERVOIR:—Storage and distributing reservoir for Jones Falls supply. Maximum depth 65 feet. Capacity 495,000,000 U. S. gallons. Daily consumption 10,000 U. S. Gallons. The inlets to the reservoir are two, one at the upper end and the other about the middle of the reservoir both of them discharge into the reservoir at the bottom. The outlets are at the lower end of the reservoir three-fourths of a mile from the upper end, and at three levels, viz., 15, 26 and 39 feet below the surface.

LAKE MONTEBELLO:—The receiving reservoir of the Gunpowder supply is 30 feet deep. All the other reservoirs 20 feet deep. In 1881 a difference of 10 degrees to 12 degrees Fahrenheit was noted between the temperature of the surface water and water at a depth of 50 feet in Druid Hill Reservoir.

In the latter part of November and in December, 1882, and in January and February, 1883, the water supplied from Druid Hill Reservoir (Jones Falls supply) again was bad, while that from the Gunpowder supply was good.

In a letter dated January 8, 1883, Mr. Martin writes to me as follows: "We have had bad water from our Jones Falls supply for two months. The big supply from the Gunpowder has been very good. Don't know whether wasting at the bottom of the storage and receiving reservoirs has kept it from being bad or not, it nevertheless is very good."

February 1, 1883, Mr. Martin writes:

"The only place we had bad water was in Druid Lake 50 feet down from the surface while the surface was good. And this is the only basin that a flow of waste from the bottom had not been kept up right along since last summer.

"In those basins where this flow has been kept up the water is and has been very good. As soon as I found the water bad I commenced to waste from the bottom, and in a short time the water was much better, and now is pretty good. Time alone will prove whether wasting at the bottom is the thing to continue, so far it has done good."

February 16, Mr. Martin writes in answer to questions:

"I found the water in Druid Lake good at 5, 10 and 15 feet below the surface, but bad below that. The water was bad at the flow line to the city main. The water was drawn off at a point 30 feet below the flow line to the city mains. I think the accumulated bad water below the flow line had a tendency to impair the quality of the later above it."

March 8, Mr. Martin writes:

"The water in Druid Lake has got all right again, we have no bad water in any of our lakes or reservoirs."

In the paper before us it is stated that while the water drawn from the pipes leading from the collecting and storage reservoir was bad, it improved after being discharged into the distributing basins. Mr. C. S. D'Invilliors (member of the club) informs me that it is his impression that the collecting reservoir for the city of Reading (that mentioned in the paper) is about 70 feet deep and that its capacity is great compared with its catchment area. I do not remember the data of the completion of this reservoir, nor the length of time the water has been stored. It is probably two or three years. Light would be thrown on the subject did we have before us all the data as well as the plans of the reservoir.

From the data furnished by Mr. Martin, the water in Druid Lake seems to have fouled in two years, from 1881 to 1883.

A theory which these facts seem to indicate is that products of *decaying* vegetation sink to the lower water in deep reservoirs where decomposition is suspended for want of oxygen, the gases are absorbed by the water which upon contact with the air are fully oxidized.

As a prevention, surplus water should be wasted from the *bottom* of the reservoirs and not over the weirs. As a cure, *aeration* by means of shallow distributing reservoirs receiving the water on the surface and if possible from fountains.

In 1881, the newspapers of Baltimore stated that (chemists failed to discover impurities after testing the water which caused complaint) this was probably because Dame Nature had forstalled them.

I would, in this connection, call attention to the fact that in the proposed Quaker Bridge Dam, on the New Croton Aqueduct, no provision seems to have been made, as far as can be learned from published plans, for drawing off the water from the lower levels. As this dam will be of almost unprecedented depth, the same trouble may be expected as in Baltimore and Reading unless this precaution is taken.

* The following table gives the results of the measured yield from streams supplying the cities of New York and Boston during the dryest year on record, viz., 1880:

Name of Stream.	Cities Supplied	Drainage area sq. m.	Period of Obs. years.	Minimum Year 1880. Inches of Rain. Loss. Flow.	Av. daily flow mil. of gals. total area	Av. daily flow mil. of gals. per sq m.
Croton	New York	338 82	18	3716-2196-1520	264 0	725
Sunbury	Boston	78 80	9	3318-2567-1249	46 3	594
Mystic	Boston	27 00	8	3442-2214-1228	15 7	582
Cochituate	Boston	18 67	32	3583-2553-1060	9 1	487

Also see annual report of the Department of City Works, Brooklyn, N. Y, 1880, ENGINEERING NEWS, April 3d, 1880, page 122.

Report of Tenth Census of U. S. Statistics of Power and Machinery employed in the United States, ,pp. 17 and 21.

** Tumbling Run dam is one of the feeders of the Schuylkill Canal, its drainage is well wooded and not subject to artificial pollution.

Dam and Siphon-weir of the Reservoir of Mittersheim.

The reservoir of Mittersheim supplies part of the canal of the Sarre coal mines and is formed by a barrage in the valley of Naubach, where it constitutes a reserve of water having a surface of 261 hectares, and a maximum depth of 8m.10 above the bottom sluices. Its total capacity is 7,000,000 of cubic meters, and of this quantity, 5,800,000 (equal to a volume of water 3m.46) can be appropriated to the supply of the canal. Local circumstances require that the regulation level of the reserve should not be appreciably exceeded, and to ensure the perfect working of the weir, it has been necessary to reduce this limit to 0m.05.

DAM:—The dam is 332m.50 in total length, 8m.92 in depth from the capping to the bottom plug or sluice, 6 meters in breadth at the top, and attains a maximum breadth of 36m.80 at the base, in the bottom of the valley.

SIPHON-WEIR:—The regulating apparatus consists of two large cast-iron siphons, 0m.70 in interior diameter and 0m.022 in thickness, communicating, by their ascending branch, with the reservoir at 3m.50 below the reserve, and by their descending branch, with a discharge canal in which their *orifice* is kept *under* by means of a small barrage. A small tube, 0m.15 in diameter, is joined to each siphon and follows it throughout the whole of the bend. The lower orifice of this tube discharges into the same canal in which the is also *submerged*, while the upper orifice opens into the reservoir exactly on a level with the reserve. This tube serves as a fetching tube,* (*amorceur,*) for the siphon, and both are in permanent communication by means of a bent pipe, which connects their most elevated points. The head of the fetching tube is in cast-iron, and is enlarged in the shape of a bell, expanding horizontally to an arc of a circle with a radius of 0m.80. The two sides or lips (levres) of this head are profiled in such a manner that the lower lip presents to the water a horizontal line of overfall placed exactly at the normal level of the reserve. The upper lip is terminated by a rounded surface, tangent, in its whole development, to a horizontal plane passing at 0m.005 above the lower lip. From these arrangements it results that

the orifice of entrance is only submerged when the level of the water rises to more than 0m.005 above the regulation reserve. The fetching (*amorcement*) is then effected in the following manner:

As soon as the water rises above the regulation reserve it flows over the lower lip of the fetching tube; if this elevation attains 0m.005, the entrance orifice of the fetching tube is submerged, and from that time the air contained in the fetching tube, in the siphon, and in the upper tube, ceases to be in communication with the atmosphere. Then the water, in overflowing, draws the air from the small tubes and exhausts that of the siphon, and there ensues a diminution of pressure in the interior of the apparatus, the water ascends into the siphon, the fetching takes place and finally the siphon works with increasing speed and discharge.

But another phenomenon prevents the pressure from indefinitely diminishing, and the delivery from indefinitely augmenting. The increasing velocity of the water entering the fetching tubes creates, near its head, a partial depression in the plane of the fluid; this depression deepens in proportion to the augmentation of speed, and at last reaches and uncovers the upper lip of the orifice, thereby causing the admission of a certain quantity of air into the apparatus, a consequent increase of interior pressure and a diminution of speed. The same facts being successively produced, there results from these two opposing tendencies, a series of oscillations corresponding to the shutting and liberating the upper lip of the fetching tube. This state of agitation soon ceases, and a steady movement is established, during which there is a simultaneous issue of water and air.

When the rising of the water ceases, the level of the reservoir lowers and the same phenomena are produced in an inverse direction; the siphon action stops, and the flow is arrested, when the plane of the water returns to its normal height.

A few millimetres of elevation in the plane of the water, above the fetching tube, suffice to cause a marked increase of speed. The air ceases to enter and the water escapes from the filled tube before this elevation has attained the perishable limit, 0m. 05. The discharge is then 0m. 60 per second, a quantity greater than the maximum delivery of the rising.

In order to exercise complete control over the apparatus, the head of the fetching tube has been disposed in such a manner that it can be raised or lowered in a single piece, by the aid of a regulating screw, the impermeability of the communications being assured by free dilatation joints. In addition, a small vertical iron valve gate has been placed in the head of the fetching tube, and it can move round a vertical axis, without ceasing to fit closely to the interior of the two lips, which allows the entrance aperture and consequently the discharge to be varied. The regulating is effected once for all, and the apparatus afterwards works automatically and requires no supervision.

The apparatus is double, and consists of two siphons each of which is furnished with its own fetching tube with tube of communication. Thus each siphon forms a complete system capable of working by itself, while the other may require to be examined, repaired, or regulated.

All the pipes of the two siphons are contained in a square covered shaft, 6m.56 square at top; the thickness of the sides 1m.20 at the upper part increases by reason of an exterior tapering of one-tenth, and of various interior counterforts serving as supports to the castings. In addition, two small semi-circular arches, 1 meter and 1m.60 in breadth, shore up the tops of the sides in order to resist the thrust of water, in the event of the shaft being emptied. The lower arch bears the heads of the fetching tubes and the siphons, while the upper one, perpendicular with the first, carries the lifting jack-screw of the bottom sluice and the covering slabs. Two culverts terminate in the center of the well: the one on the up stream side, is 1m.80 span and 1m.80 in rise below the key, and establishes a constant communication with the reservoir so that the heads of the fetching tubes are always in still water; the other, on the down stream side, is 1m.20 by 0m.60, and is kept closed by a cast-iron sluice which can be worked from the top; it runs into the discharge canal and serves to empty the reservoir in case of need. By opening the cast-iron sluice and closing the first culvert, by means of small beams fitting in grooves contrived for this purpose, the well can be emptied, and all the parts of the siphon examined and repaired. Their ascending branches terminate in the reservoir by bell shaped circular orifices, and are fitted with gratings and clack-valves. The discharge culvert, into which the descending branches of the siphons and fetching tubes empty themselves, is closed on the down stream side by a small barrage-weir which retains the orifices of these pipes constantly under water.

The idea of employing fixed siphons as weirs for the regulation of a reserve was proposed by M. Girard and applied to the Southern canal, but large siphons have been employed there, which required considerable variations in the level of the reserve, to put them in motion or to stop them.

The peculiar conditions existing at Mittersheim, and the very restrained limit permissible, 0m.03, led M. Hirsch, Engineer "des Ponts et Chaussees," to invent the special system of fetching tubes which has completely fulfilled the purpose for which it was intended.

The works were planned and directed by MM. Benard, engineer in chief, and Hirsch, resident engineer "des Ponts et Chausses," from 1864 to 1866. Water was let into the reservoir in December 1836, and the siphons were put into action, for the first time, on the 12th of January following.

*The word "fetching" is employed in the case of a pump when pulling, the motion and the circumstances being analogous it is used here. (Translator).

The Theory and Calculation of Earthwork Slopes.*

Written for ENGINEERING NEWS.

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1. INTRODUCTION.—The term earthwork includes excavations, embankments, terraces, mounds and other constructions formed in or with the natural earth. The earth is to be regarded in discussion as homogeneous and inelastic, and as consisting of particles more or less united by cohesion between which friction is generated whenever exterior forces tend to effect a separation. As some kinds of earth when dry are destitute of cohesion, these will first be considered under the term loose earth.

The problems to be discussed in these pages are those of the equilibrium and stability of banks of cohesive earth. Formulas are to be deduced for instances showing the relation between height and slope when rupture or caving just occurs, and then methods are to be explained by which the height and slope may be so adjusted that stability and security may be ensured. The subject has thus far received little or no attention in this country, and experiments are much needed to render its discussion entirely satisfactory. It is believed however that the rules and formulas deduced by theory will ultimately prove of practical value to engineers.

2. LAWS OF FRICTION.—The following are the laws of friction as ascertained by experiment for the case of incipient motion: First, the force of friction between two surfaces is directly proportional to the normal pressure; second, it varies with the nature of the material, and third, it is independent of the area of contact. These laws may be expressed by the equation,

$$F = f N \qquad (1)$$

in which N is the normal pressure, F the force of friction perpendicular to N, and f is a quantity called the coefficient of friction which varies with the kind of material. As F and N are both in pounds, f is an abstract number; its value for earth ranges from about 0.5 to 1.0.

3. EQUILIBRIUM OF LOOSE EARTH.—If a mass of earth be thoroughly loosened so as to destroy all cohesion between its particles, and then be poured vertically upon the point D in the horizontal plane $B\ C$, it will form a cone $B\ A\ C$, all of whose elements $A\ B$, $A\ C$, etc., make equal angles with the horizontal. This angle $A\ B\ C$ is called the "angle of repose," or sometimes "the angle of natural slopes," and it is found by experiment that each kind of earth has its own constant angle. The particles of earth on such a slope are held in equilibrium by the forces of gravity and friction. Let φ be the angle of repose $A\ B\ D$, and f the coefficient of friction. In the figure draw W vertically to represent the weight of a particle, and let N and F be its components normal and parallel to the slope. Now since motion is about to begin,

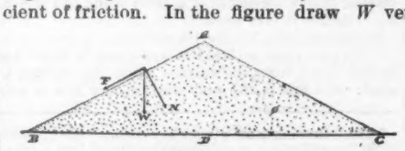

FIG. 1.

$$F = f N.$$

Also since the angle between N and W is equal to the angle of repose φ, we have from the right angled triangle

$$F = N \tan \varphi$$

Therefore we find the important relation

$$f = \tan \varphi \qquad (2)$$

that is, the coefficient of friction of earth is equal to the tangent of the angle of repose. It is hence easy to determine f when φ has been found by experiment

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WATER.

BELMONT, MASS., wants water. The Watertown Water Co. promise to supply an unlimited quantity.

A CAPITALIST of Cleveland, Tenn., is trying to buy the Rahl Springs for the purpose of bringing water by pipe to his town.

T. H. LINEEN in behalf of the Holly Company is figuring to put in water-works at Ripon and Beaver Dam, Wis.

IT is estimated that the number of lakes in the State of Minnesota are 11,000. Becker county has 232 and nearly all are well stocked with excellent varieties of fish.

A BILL passed the North Carolina Legislature on March 5, to incorporate the Greenboro Water Supply Co. Also a bill introduced to authorize the town of Durham, N. C., to issue bonds for the erection of water-works.

LEIF, son of Eric the Red, who colonized Greenland about A. D. 1,000 and is supposed to have landed in Nova Scotia and discovered Nantucket, is to have a drinking fountain erected to his memory on the Back Bay Park, in Boston.

PHILADELPHIA is after the "defilers of the river" Schuylkill. Judge Thayer at an early day is to pass sentence on those already convicted. This action is taken because the parties convicted have taken no measures to abate the nuisance though given time to do so.

AUSTRALIA is finding that, under some of the districts subject to drought, great underground rivers are flowing. One of these has just been struck in the Gwydi district, 390 miles north of Sidney, where the water was struck at a depth of 130 feet and rose 42 feet in three hours.

IN Paris there are 250 miles of water mains, and a city system of pipes that would, if developed, reach from Paris to Bucharest. All the stations are connected by their own telegraph lines. This system is the gradual development of the scheme for supply worked out by M. Belgrand in 1854, and continued by him to his death in 1878.

THE Owensboro and Nashville, an 84-mile branch of the Louisville and Nashville in Kentucky, had a contract with the Owensboro Water Company to furnish it water for two locomotives at $30 per annum and $25 for each additional engine. The Water Company struck for more money, and the railroad, claiming the contract to be perpetual, has applied for an injunction.

THE Wyandotte and Armourdale Water Co., of Wyandotte Co., Kansas, was chartered on Feb. 26. The Directors are: Vincent J. Lane and W. H. Ryus, of Wyandotte; Franklin W. Patterson, of Armourdale; Stanton D. Loring, of Boston, Mass.; Samuel A. Miller, George J. Long and William Reinicke, of Louisville, Ky. The amount of the capital stock of the said corporation is $300,000, divided into 3,000 shares of $100 each.

W. J. MILNER, Supt. of the water-works of Birmingham, Ala., is showing enterprise by issuing a circular to all water-works companies, with enquiries concerning water-meters. A list of 18 questions is appended, enquiring as to the kind of meter used; the one preferred; percentage of correctness; who furnishes them and how and what rental is charged; when read, how tested, where placed, how protected from frost; discount allowed, if any, etc., etc.

AT a meeting of the Water Committee of the City of Pittsburg, Pa., held March 4th, 1885, the superintendent reported that a test of engines Nos. 1 and 2 had been made, but in which many minor points had been omitted. The engines showed a duty of 135,403,305 pounds of water raised one foot high for every 100 pounds of coal consumed. At the same meeting it was also stated that the new Allegheny city engines built by Messrs. E. P. Allis of Milwaukee showed duty of only 107,000,000 pounds.

A RECENT work, "The London and Provincial Water Supplies," gives the daily consumption of water in London at 144,592,772 gallons, or nearly 30 gallons per head of population. Glasgow is fortunate in her supply, receiving 50 gallons per head per diem from the pure waters of Loch Katrine. The writer says that the population of London is now increasing at the rate of 100,000 per year. If this rate continues until 1919 London will have a population of about 10,000 000, and the water problem will be a very serious one.

THE Pittston, Pa. Water Works are under contract. The plan includes a filter, 140 feet long and 10 feet wide, parallel to the river and a pipe line from the filter to the well at the pumping station. The filter will be made of 10 cribs, each 14 feet long made of 3x12 inch planks, arranged like stationary slat blinds with 2 inch space between planks; the top is covered with 2 inch planks with spaces between and above this is 2 feet of sand and gravel. A 30 inch, and then a 24 inch pipe leads to the pumping well and to the Pennsylvania Co.'s pumps. The main pump well is 10 feet in diameter and 10 feet deep built of hard brick. The contractors are Thacher & Breyman, of Toledo, Ohio, submarine engineers and divers. Work will be commenced as soon as the weather opens.

BIDS were opened on the 11th inst. by Captain J. H. Lord, A. Q. M., depot Q. M. Cheyenne, Wyo., for constructing a system of water-works at Fort D. A. Russell, Wyo.

CHESTER B. DAVIS, of Chicago, is preparing plans for water-works for the city of Aurora, Ill., population 20,000, and expects to ask for proposals before May 1st.

The works will cost from $125,000 to $150,000; about 15 miles of mains will be laid. Mr. Davis is also preparing sewerage, drainage, and street grade plans for the city of Cedar Rapids, Iowa; population 22,000. It is expected that several miles of sewers will be constructed during the coming season. Bids for the Mason City, Iowa water-works, also planned by Mr. Davis were opened February 25th; the contract is not yet awarded on March 4.

A SUPERINTENDENT of water-works of Toronto, Can., is advertised for. The following as the duties proposed to be performed by the manager of the Water Works:—He shall have control over all the other officers of the department, and he shall keep the committee informed as to the true conditions of the duties and work performed by each individual employé under his charge. He shall attend all meetings of the Water Committee, report on supplies wanted and their probable cost, where mains are required, probable cost of construction, and probable immediate revenue derivable therefrom. He shall attend to the enforcement of by-law 886, and that all contracts are faithfully fulfilled. It shall be his duty to examine into and report upon all complaints in connection with the distribution of water or collection of water rates, and also enforce the vigilance of the water inspectors. He shall superintend the purchase, measurement, and distribution of all supplies. He shall obtain from the chief engineers under him at the engine houses a report of the daily consumption of fuel, number of gallons pumped, indications of the gauge, pressure, and all other information regarding the work at the pumping house.—*Mail.*

THE PARIS WATER SUPPLY.—The Municipal Council of Paris has called a special session to consider the best means of bringing additional supplies of water into the capital. Since the month of August last the administration has been requested to study the subject, the importance of which was rendered very evident by the threatened cholera visitation. Fortunately the municipal engineers had been for a long while engaged upon the subject, and they were therefore able to present a very complete scheme, in spite of the short time at their disposal. This project proposes the acquisition and utilization of four groups of supply in Burgundy, Normandy, Brie, and on Loing. The cost of property to be purchased would be less than 1,000,000f., one-third of which would be recovered by subsequent sales. It was proposed to utilize first the Normandy and Brie sources of supply, which would be brought to Paris by two aqueducts, which would cost, it was estimated, from 60,000,000f. to 70,000,000f. The amount of water delivery daily would be 240,000 cube meters, and the price which this would realize would be of .01f. the meter, equal about 3,000,000f. a year.

NEWS OF THE WEEK.

Contracting.

C. & O. Depot in Pittsburgh, Pa. Pittsburg is to have no union depot, the Baltimore & Ohio people having decided to build a new passenger and freight depot at a cost of $500,000, independent of other roads. They will also greatly increase their terminal facilities in the way of coal-yards, elevators etc., at that point.

The N. O. Exposition Sued. Jones & Laughlin of Pittsburg filed a suit against the World's Exposition at New Orleans for $24,000. They ask for judgment with mechanics and venders' liens on the buildings. The bill sued on is for shafting in the machinery department, which was to have been paid for upon delivery on the cars at Pittsburg.

Location of the Omaha Carshops. The Omaha company is formulating plans to erect new carshops at Altoona, three miles from Eau Claire, in the summer. The shops will consist of a car department and blacksmith and paint shop, and they will cover, with side tracks, from fifteen to twenty acres of ground. The cost of building the shops is now being estimated, and it is expected that work will be commenced on them early in the spring. There will be employed nearly 200 workmen.

Stone Arch Bids. The committee on roads and bridges of Minneapolis, Minn., opened the following bids for the construction of a stone arch over Bassett's creek on Third avenue north: Jeremiah Crimmins, $4.49 per cubic yard stone masonry; McDermott & Hickey, $4,700 for the bridge, making a little more than $10 per yard; J. J. Palmer $6.93 per cubic yard; R. M Riner, $6.48 per cubic yard; T. F. Hanlan, $5.50 per cubic yard; William Mauer, $7.25 per cubic yard; Thomas Daly, $9.75 per cubic yard; Dennis Thainor, $6.73 per cubic yard yard; E. E. Munson, $7.75 per cubic yard.

Cleveland Improvements.—Cleveland O., is to spend $350,000 on pavements and sewers, according to the *Cleveland Herald*, during the present year.

A Town meeting of the City of Orange, N. J. was held on March 1st, to discuss the advisability of constructing a system of sewers for that place. The question of bonding the city for the funds required is to be voted upon during the present month. About 500 citizens were present at the meeting and it was unanimously resolved that the sewerage of the city was urgently demanded and that the sewers should be at once constructed. Very full information as to the building of the sewers and the disposal of the sewerage had previously been presented to the township committee in a report, made at their request, by J. J. R. Croes. C. E., who recommended the separate system of sewerage and its disposal by chemical treatment and the filtration of the effluent through the soil. Ground available in quality and area is found at the point of lowest elevation on the north side of the town.

Railroads, Bridges and Canals.

A Sinaloa R. R.—Two vessels have left San Francisco with rails and other materials for the construction of the railroad from Mazatlan to Rosario, Sinaloa.

A Cleveland Bridge.—A bill was introduced into the Ohio State Senate on February 26, authorizing Cleveland, O., to borrow $65,000 to build a new bridge over Walworth Run at Pearl Street.

A Wabash Bridge.—The Wabash people have just completed an iron bridge over the Wabash, at Belden, which cost $10,000 in round numbers, and another fine iron bridge is in process of construction at Decatur Ill.

A Long Island Canal Project—The question of connecting the head waters of Flushing Bay with Newtown Creek, and thus making a continuous tidewater canal, was discussed at a meeting in the Town Hall of Newtown. An organization was effected for the purpose of making further efforts to carry out the project.

The Gulf, Col. and Santa Fe.—GAINESVILLE, TEX., February 27th.—It is reliably stated to-day that the proposed extension of the Gulf, Colorado and Santa Fe, from Fort Worth to a connection with the Atchison, Topeka and Santa Fe, will start on its northern march at the first breaking of spring.

Air Line to New Orleans.—HELENA, ARK., March 2—A united effort is being make by the citizens of Helena and Phillips County to get the Mississippi Valley Railroad to put a transfer boat at this place. The road would then have to build a track eight miles long to give New Orleans and St. Louis a direct air line.

San Joaquin and Sierra Nevada Railroad.—The work on the San Joaquin and Sierra Nevada Railroad is being pushed forward rapidly, and the grading and bridge-work between Burson, and Valley Springs has been completed. The road is to be extended to Altaville as soon as possible, and will eventually pass through Murphy's and up the Stanislaus river to the Calaveras Big Trees. When Altaville is reached this line will be the shortest route to the Yosemite Valley.

Narrow-Gauge Extension.—LONGVIEW, TEX., February 25.—Brad Barner, Vice President of the Galveston Sabine and St. Louis Narrow-Gauge Railway Company, proposes to pay up the construction force who are extending the road. He will pay out between $15,000 and $20,000 between this and Saturday. The road will be rapidly pushed to connect with the Bremond Road at Wood's Station, twelve miles below Carthage, which will be reached by April 1. Iron is laid to Martin's Creek, ten miles below Easton.

High-Speeded Locomotives.—The New York Central people are building, at their shops, three locomotives for their fast trains which it is expected will eclipse in speed any locomotives now running. The Albany *Journal* says: "They will be capable of running sixty miles an hour with ease. The cylinders of the engines are to be 17 x 20 inches, with sixty-eight inch drivers, and when completed will undoubtedly be the finest specimens of locomotive mechanism in the world."

The Turtle Creek Valley Road.—PITTSBURG, PA., March 2.—A syndicate of New York, Philadelphia, and Pittsburgh capitalists have purchased the charter of the Turtle Creek Valley Road route, which extends from Turtle Creek to Saltsburg, a distance of eighty-three miles, and arrangements will be made for the immediate opening of work on the road. The route will open up a rich mineral country and give the Rochester & Pittsburgh and Seaboard & Western Roads a far more advantageous outlet from Pittsburgh.

A New Detroit Line.—ROCHESTER, IND., February 26. General Manager Talmage, of the Wabash system, made a tour of inspection over the Chicago and Atlantic Railroad to-day from Chicago to this city. Negotiations are pending between the two companies whereby the Wabash Company will secure the right to run trains over the Chicago and Atlantic between Chicago and Newton, thence over the Wabash, St. Louis and Pacific to Detroit. If the arrangements are perfected the Wabash will have a short line between the two cities, the distance being 294 miles over the proposed route.

The Woodland Avn. & West Side street railway Co., of Cleveland, O., was incorporated on February 26. Capital, $1,000,000.

Minneapolis Railroads.—An estimate recently made of the number of miles of railroad owned and operated by railroads centering in Minneapolis shows a total of 19,296 miles. The length of the several roads is as follows:

Chicago and Milwaukee	5,774
Chicago and Northwestern	5,645
Chicago, Rock Island and Pacific	3,036
Northern Pacific	2,547
St. Paul, Minneapolis and Manitoba	1,467
Wisconsin Central	549
St. Paul and Duluth	208
Minneapolis, Sault, Ste, Marie and Atlantic	45
Minneapolis, Lyndale and Minnetonka	25
Total	19,296

A New Canadian Railway—On March 1, the Toronto Board of Trade petitioned the Ontario Government for a grant of 5,000 acres of land per mile for a proposed railway from Irondale, in Snowden district, to connect with the Victoria R. R., near Kinmount. The length is 50 miles, and 20 miles have been contracted for by Pittsburgh, Pa., capitalists who are interested in developing iron mines in Snowden. They propose to erect works of 60 tons daily capacity. The Dominion government has already promised a bonus of $3,000 per mile to the railway. Chas. G. Pusey, of Pittsburgh, is managing the affair.

The Proposed Storm King Bridge.—NEWBURGH March 6th—The Massachusetts legislative party this morning inspected the site for the proposed bridge across the Hudson River from Storm King to Breakneck Mountain. The projectors ask Massachusetts to guarantee the interest on bonds and for construction not exceeding $5,000 000. It is not known what action the Railroad Committee will take. The members declined to furnish their views for publication. The bridge is said to be needed to shorten railway communication between New England and the coal fields. The party returned to Boston to-day.

An Immense Locomotive.—There is now nearly completed in the shops of the Baldwin Locomotive Works, Broad and Spring Garden Sts., Phila., the largest locomotive ever built in America. It is intended for service on the Dom Pedro Segunda Railroad, of Brazil, and will probably be sent there this month. It is of the decapod class, with ten driving-wheels each 45 inches in diameter and is mounted on a pony truck. The cylinders are 22 inches in diameter, with a 26 inch stroke. The boiler is 5 feet 4 inches in diameter, the fire box 10 feet long and 43 inches wide, and the tender has a capacity for 3500 gallons of water.

The locomotive is designed for a gauge of 5 feet 3 inches and will draw between 450 and 500 gross tons of cars and lading up a grading of 105 feet per mile. The wheels are so arranged that short curves can be rounded without difficulty.

The Proposed Fort Wayne and Akron. TIFFIN, O., Feb. 25.—The project of the Fort Wayne and Akron Railroad Company, which has just recently been incorporated, is intended to open from New York to Chicago a direct midland route shorter by several hundred miles between these two commercial centers than any of the present lines connecting them. The points given to indicate the direction of the midland route are from New York to Hoboken, Flatbrookville, Hazelton, Bloomsburg, Clearfield, Punxsutawney, New Castle, Akron, Tiffin, Findlay, Ottawa, Fort Wayne, Rochester to Chicago. Branches are proposed to extend from Punxsutawney on the main line through Pittsburg, Wheeling Caldwell, McConnellsville, Logan, Chillicothe, Hillsboro, to Cincinnati, and from Rochester, Ind., on the main line, through Urbana, Ill., to St. Louis.

Canadian Construction.—Following close upon the Government's refusal to give any information respecting the trestlework on the eastern section of the Canadian Pacific Railway comes the news that a large trestle over a ravine near Spanish Forks broke down recently under the weight of a passing train. Six cars went over and the whole side of the trestle was torn away. An immense gang of men had to be put on for two days and nights to repair the trestle so that trains could manage to go slowly over it. One of the construction foremen employed on the road, who arrived here, says that in all his twenty-five years of railway building he never saw any such work as that now being done on the road between Sudbury and Port Arthur. Poles and brush are laid across swamps, he says, and the sleepers laid on this formation. As the ground is frozen hard rails can be laid and the trains run over it. The condition of things when the spring comes can be imagined. Some embankments are built of frozen snow and covered with earth and gravel, and upon this the company receive payment. The men get drafts for their pay, and to get these cashed they must go to Sudbury or Montreal, and the contractor charges them full railway fares on construction trains.—[From the Chicago *Mail.*]

The West Shore.—Rumors have lately been rife that the New York Central Railroad Company has got control of the West Shore Railway, and that a cessation of the war between the two concerns may be looked for at any moment. That something of the kind will happen

some day within the next two or three years is as certain as that we shall have summer and winter during that period, but of the precise time and manner of its happening, we believe that nobody, not even William H. Vanderbilt, can speak with confidence.

The West Shore Railway is remarkable, not only for its colossal dimensions as a financial disappointment, but also for the eminence of the financial magnates who have been its victims. The most experienced judges of railway enterprise in Wall street examined the plans and estimates for its construction, and concluded that it would be profitable. Its securities found a ready sale up to the very day when it began to carry passengers and freght, and its collapse was to most people as unexpected as would have been that of the New York Central.

It was originally supposed that the entire road from Weehawken to Buffalo would be built and equipped for about $40,000,000. In order to avoid the statutory limitation of ten per cent upon dividends on this amount, a company was formed, called the North River Construction Company, with a cash capital of $10,000,000, and this company contracted for the job at $50,000,000 in West Shore bonds and $40,000,000 in West Shore stock. The scheme was to sell the bonds for enough to pay for the road, and leave the stock to be divided as a bonus to the stockholders of the construction company. So flattering were the prospects of the enterprise that the construction company's stock was eagerly sought for at a premium, and even West Shore stock at one time brought over 30 cents on the dollar. Estimates were made—undoubtedly in good faith—showing that the net earning of the road would be $1,725,000 in 1884, and $6,000,000 in 1885. The $50,000,000 bonds bear only 5 per cent interest, equal to $2,500,000 a year, so that there would be $1,225,000 to be divided on the $40,000,000 stock in 1884, and $3,500,000 in 1885.

How completely wrong these figures were it is not necessary to explain in detail. It is enough to say in general that the road, with its equipment, instead of costing $40,000,000, has swallowed up over $60,000,000 in cash; and $5,000,000 more will be required to finish it. Its terminal works at Weehawken have cost $6,000,000 as an independent undertaking, and no statement has been made of the various claims for land and for the right of way which remain to be adjusted and paid. Its net earnings up to the present time have been less than nothing, and the bonds have no value except upon the prospect of their purchase by the New York Central managers.

To represent the entire outlay upon the road there are in the hands of the public $50,000,000 of first mortgage bonds, on which no interest has been paid since January 1, 1884, and which at the market price are worth about $18,000,000; terminal bonds, worth say $4,000,000 more, and stock, unsecured claims, and receiver's certificates, worth perhaps $3,000,000 more. In round numbers the speculation has resulted in a loss of at least $35,000,000 to those who put their faith and their money into it, besides reducing the dividends on $80,000,000 of stock in the New York Central Railroad Company from 8 to 6 per cent, and depreciating its market value from 125 to 95, thus causing a loss to its holders $27,000,000 more.—New York *Sun*.

Index to Periodical Literature.

Railroad Economics. *Pullman; A Social Study.* A description of the town built and owned by the Pullman Palace Car Co., near Chicago. Its construction and management. A study of the question of its success from a social standpoint. Its defects By Richard T. Ely. *Harpers*, Feb., 1885, pp. 452 to 466.

Railroad Excavator. *American Railroad Ditching Machine.* Illustration and brief description of a simple arrangement consisting of two pairs of derricks with appropriate rigging, and a bucket to be worked by each pair, mounted on an ordinary flat and moved by a locomotive. Used for two years satisfactorily on the C. M. & St. Paul R. R. *R. R Gazette*, June 13, 1884, p. 441.

Railroad Excavator. *Barnharts Steam Hoist and Wrecking Car.* It is claimed to have a capacity of from 2,000 to 3,000 cubic yards per day, of earth or gravel, consuming ¼ ton of coal; and a capacity of 20 tons for wreckage purposes. Detailed description and illustration. *R. R. Gazette*, Feb. 13, 1885, p. 100.

Railroad Management. *Division of Freight at New York.* Reply to the complaint of New York Merchants and of the Traders and Traveler' Union regarding the diversion of freight by the various trunk lines, by Albert Rink, addressed to the U. Y. Railroad Commissioners. It gives the railroad side of the question. *R. R. Gazette*, Feb. 6, 1885, pp. 81 and 82.

Railroad Signals. *American Pneumatic Signals.* Full description, with illustrations, of the system of the American Pneumatic Signal Co., which is completely automatic in its working, and can be used either at crossings, etc., or in complete block systems. *R. R. Gazette*, February 19, 1885, pp. 98, 99.

Railroads, Street. *Les Voies de tramways en Angleterre et a Paris.* A comparison between the tramways in England and France, with an historical allusion to their introduction in New York. Sketches and account of the construction of the rails and in the places mentioned. Based on a report by M. Barabout. *Nouvelles Annales de Constructions*. February, 1885, pp. 26 to 31.

Railroad Switches. *Foot-guards for Frogs and Guard Rails.* A description of various plans devised for preventing accidents from catching the foot in frogs and guard rails. Illustrated. *R. R. Gazette*, May 9, 1884, p. 351.

Refrigeration *By Cold Air Direct.* A description of Sturgeon's machine for reducing the temperature 100° F. The action is entirely mechanical, no chemicals being employed. Illustrated. *Mechanical News*, February 15, 1885, p. 361.

Ship Railways. *Tehuantepec Ship Railway.* A very carefully written and fully illustrated article in which the route and terminal harbors are briefly described, and the lifting pontoon, cradle, floating turntable, etc., with the methods of operating, are described in detail. *Engineering News*, February 14, 1885, pp. 97 to 100.

Steel. *Carbon in Steel.* Final report on experiments bearing upon the question of the condition in which carbon exists in steel. Read by Sir Frederick Abel before the Institution of Mechan. Engineers, London. With discussion. *Iron*, February 6, 1885, pp. 115 to 119; *also*, begun in *Engineering*, February 6, 1885, pp. 150, 151.

Testing Machines. *Improved Lever Chain-Testing Machine.* Description of a new apparatus built by Riehlé Bros., with a capacity of 200,000 lbs. and a range of from 20 inches to 90 feet, for testing chains, wire, or hemp rope, bridge irons, etc. *Iron Age* Feb. 5, 1885, p. 19.

Testing Machines. *The Emery Testing Machine.* A description of the machine, and of the principles upon which it works, with detailed illustrations. *Amer. Jour. of R. R. Appliances*, Dec. 1, 1884, pp. 281 to 283.

Torpedoes. *Autobiography of a Whitehead Torpedo, No, 1.* The first of series of articles (illustrated) designed to explain in detail their manufacture, mode of operation and efficiency. *Engineering* Feb. 6, 1885, pp. 127, 126.

Tunnel, *see* **Water Supply.** *The Washington D. C., Aqueduct.*

A Washington Monument. A report giving a description of the monument, with general dimensions, weight, settlemeet, etc. A history of the work to date, and a statement of the work still to be done. Cost to date, and estimated cost of completing. Illustrated with plan and sections, on large scale. By Col. Thos. L. Casey, *48th Cong., 2d Sess. House Rep. Mis. Doc. No.* 8, Dec. 1884.

Water Supply, Washington. *The Washington D. C. Aqueduct.* A description of the work, principally of the tunnel under construction for the increased water supply. Includes several tables of abstracts of proposals for doing the work. Compiled from the Annual Report of Maj. G. J. Lydecker. *Engineering News*, Feb. 14, 1885, pp. 105 to 107.

Market Report of Engineering Materials.

New York, March 12, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.		
Angles	2.2c. @	2.6c.
Tee	2.8c. @	3c.
Beams and channels	3.0c. @	3.5c.
Tank	2c. @	2.1c.
Shell	2¾c.	
8 sel plates, Tank	3c. @	3½c.
WROUGHT-IRON PIPE., PITTSBURGH.		
Butt welded, black ..Discount	47½	
" " galvanized "	40	
Lap welded black "	65 @	67½
" Galvanized "	47½ @	50
Boiler tubes "	60	
RAILS.		
Steel (large lots at mill)	$26.50 @	27.50
Old rails	16.75 @	17.00
Old rails, steel	16 @	17
R. R. spikes		2c
R. R. splice-plates	1.65c. @	1.75c.
R. R. Track Bolts	2.35c. @	2.65c.
Barb-wire fencing, galvanized	4¾c. @	5¼c.
" " painted	3¾c. @	4¾c.
Corrugated iron		
Nails		
Iron	2.25	
Steel	2.35	

METALS.

COPPER.		
Lake Superior	11 @	.11¼
Other Brands	10¼ @	10¾
LEAD.		
Com. Domestic	3.60 @	3.70
Lead Pipe	.06¾	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.06¾	
ZINC.		
Sheet	5.15 @	5.25

BRICK.

(Cargoes afloat)		
Haverstraw 1st per M.	$6.00 @	6.25
" 2nd "	5.62 @	5.87
Fishkill	4.75 @	5.50
Up-River		
Jerseys	5.25 @	
Long Island		
" pale		
FRONTS.		
Croton red	14.00 @	
" dark	14.00 @	
" brown	12.00 @	
Philadelphia pressed	22.50 @	23.00
Trenton "	22.50 @	23.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	65.00 @	130.00
" American	85.00 @	120.00
Fire brick	25.00 @	40.00

CEMENT.

PORTLAND.		
Robins & Co., Extra English 425 lbs. per bbl.	2.75 @	2.90
K. B. & S. English 400 lbs.	2.85 @	3.00
Burham " "	2.70 @	2.85
Rochester Castle " "	2.50 @	2.60
J. B. White & Bro. " "	2.50 @	2.60
Other brands, " "	2.40 @	2.50
Keene's fine " "	9.50 @	9.75
" course	5.25 @	5.50
Roman	2.75 @	3.50
Dyckerhoff, German 400 lbs.	2.60 @	2.65
Star, " "	2.60 @	2.65
Alsen, " "	2.55 @	2.60
Hanover " "	2.40 @	2.50
Other brands, " "	2.35 @	2.40
Saylor's American	2.15 @	2.50
F. O. Norton	1.10	
Rosendale cements	0.90 @	1.00

LIME.

Rockland common per bbl	1.00	
" finishing	1.20	
Glensfalls, common	.85	
" finishing	1.05 @	1.10
Kingston, ground	0.95	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.90 @	95
" " No. 2 "	0.75 @	0.80
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " " "	0.75 @	1.00
Brownstone, Portland, Ct. "	1.00 @	1.30
" Belleville, N. J. "	0.75 @	1.25
Granite, rough	0.60 @	1.25
Common building stone per load	2.00 @	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00

SLATE.

Purple roofing per square	6.00 @	7.00
Green "	6.00 @	7.00
Red "	15.00	
Black Penna. (at New York) "	4.50 @	5.00

LUMBER.

PINE, Common box per M.	18.00 @	20.00
" Good "		
Tally plank, 1¼ in each.	.44 @	.50
Tally boards, dressed "	.28 @	.30
SPRUCE, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	20.00 @	22.00
HEMLOCK, Boards each.	.18 @	.20
Joist, 2¼ × 4 to 4 × 6 in	.17 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1¼, 2 and 2½ in "	35.00 @	40.00
YELLOW PINE, Girders "	26.00 @	35.00
Dressed flooring "	30.00 @	40.00
SHINGLES, Extra shaved pine, 18in. "		
" sawed 18 in. "	4.50 @	5.00
LATH, Cargo rate	2.50 @	2.60

PAINT.

Lead, white, American dry per lb	.04¾ @	.05
" " in oil pure "	.05½ @	.05¾
English, B. B. in oil "	.06½ @	.06¾
Red, American "	.05½ @	.05¾
Litharge "	.05 @	.05¾
Venetian red, American "	.01 @	.01¼
Indian red "	.05 @	.10
Vermillion, American lead "	.11 @	.11½
Paris green "	.15 @	.19
Umber, Amer. raw and powdered per lb.	.01¾ @	.01½
Drop black, Amer.	.08 @	.12
" " "	.09 @	.11½
Chrome green	.05 @	.15
Oxide zinc, American	.03¼ @	.04
" French	.06¼ @	.06½

THE PETROLEUM PRODUCT. Pittsburg *Commercial Gazette*. While Pennsylvania petroleum yields 70 per cent of kerosene with a large residuum of lubricating oil, the Caspian product yields but 28 per cent of kerosene, with a refuse fit only for fuel. In the early days of Caspian petroleum the price was $2 per barrel. Now it often sells at 10 cents. Twelve thousand square miles in Southern Russia have been proved to be oleiferous, and of this vast surface only six miles are, as yet, developed. The oil bearing stratum is found to extend beneath the Caspian Sea, where it crops up in Tchelliken, a true isle of oil, which literally streams into the sea from hills and cliffs, which are entirely formed of crude paraffine.